26 JANUARY 1950 ONE SHILLING

MILITARY AIRCRAFT OF THE WORLD

FLIGHT

and

AIRCRAFT ENGINEER

OFFICIAL ORGAN OF THE ROYAL AERO CLUB

THE AVRO **Shackleton**

DESIGNED FOR MARITIME RECONNAISSANCE AND NOW IN QUANTITY PRODUCTION FOR COASTAL COMMAND, ROYAL AIR FORCE

A. V. ROE & COMPANY LTD. MANCHESTER

(Branch of the Hawker Siddeley Group)

de Havilland "COMET"

The latest development in passenger aircraft

wired for all electrical services with

B.I. Callender's

"PREN"

AIRCRAFT CABLES

BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON W C 2

MAKERS OF AVIATION HISTORY

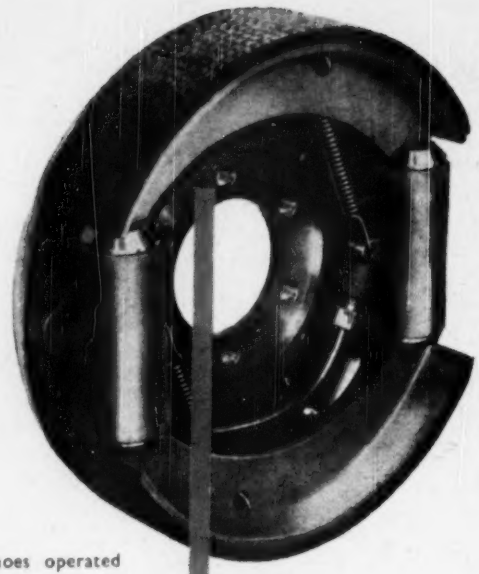
VICKERS SUPERMARINE 510

(ROLLS-ROYCE NENE ENGINE)

Developed from the "Attacker", the Type 510 has swept-back wings and tail unit to delay the onset of compressibility effects. The Supermarine design team have thus provided another example of the principle of developing an aircraft of proved design so that it gives a performance ahead of its contemporaries. The same principle enabled the famous "Spitfire" to remain unchallenged in performance throughout the world for so many years.

VICKERS-ARMSTRONGS LIMITED • AIRCRAFT DIVISION • WEYBRIDGE • AND SUPERMARINE WORKS

THE NEW HYDRA-STATIC TWO LEADING SHOE AIRCRAFT BRAKE



THIS brake consists of two self-aligning shoes operated by two wheel cylinders spaced diametrically opposite. Each wheel cylinder has two pistons of a different form : one having a slot at right angles to the axis of the bore, which operates the shoe when the brake is used in forward rotation and the other with the slot inclined at an angle to the bore which forms the abutment for the other shoe in similar condition. This inclined slot has a predetermined angle which allows the shoe to align itself accurately to the drum as well as forming the abutment. The total shoe reaction is transmitted via a shoulder on the piston to the cylinder body. By this arrangement, two-leading shoe operation is obtained in either direction, and greater power for a given input and greater stability is obtained.

TYPICAL FIGURES

5⅞" x 1½"	Approximate maximum dynamic torque 2,950 lbs. inches, at 60 lbs. per sq. inch lining drag. Two ⅝" diameter cylinders.
7" x 1½"	Approximate maximum dynamic torque 4,200 lbs. inches, at 60 lbs. per sq. inch lining drag. Two ¾" diameter cylinders.

Master cylinder for use with the above brakes is a ⅝" diameter x 1⅛" stroke design.

GIRLING

THE BEST BRAKES IN THE WORLD

GIRLING LIMITED,
KINGS RD., TYSELEY
BIRMINGHAM 11

FORESTRY PATROL

AMBULANCE SERVICE

FRONTIER WORK

NAVAL

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PHOTOGRAPHY

CROP SPRAYING

PIPELINE MAINTENANCE

SURVEYS & PROSPECTING

POSTAL SERVICES

JUNGLE RESCUE

for

Ubiquitous Service

RUNWAYS UNNECESSARY

This Helicopter is the most modern of its kind now in full production in the United Kingdom, manufactured from British materials and powered by the British Alvis Leonides engine.
This British built Helicopter is easy to fly, simple to maintain and economical to operate.

WESTLAND

SIKORSKY

S·51

HELICOPTER

WESTLAND AIRCRAFT LIMITED YEOVIL

USED **AGAIN** on the 'Bristol' New Type 170

THE NEW TYPE 170

STEEL STRIP

OF PROVED QUALITY HAS LARGELY CONTRIBUTED TO THE SUCCESSFUL DEVELOPMENT OF MODERN MACHINES

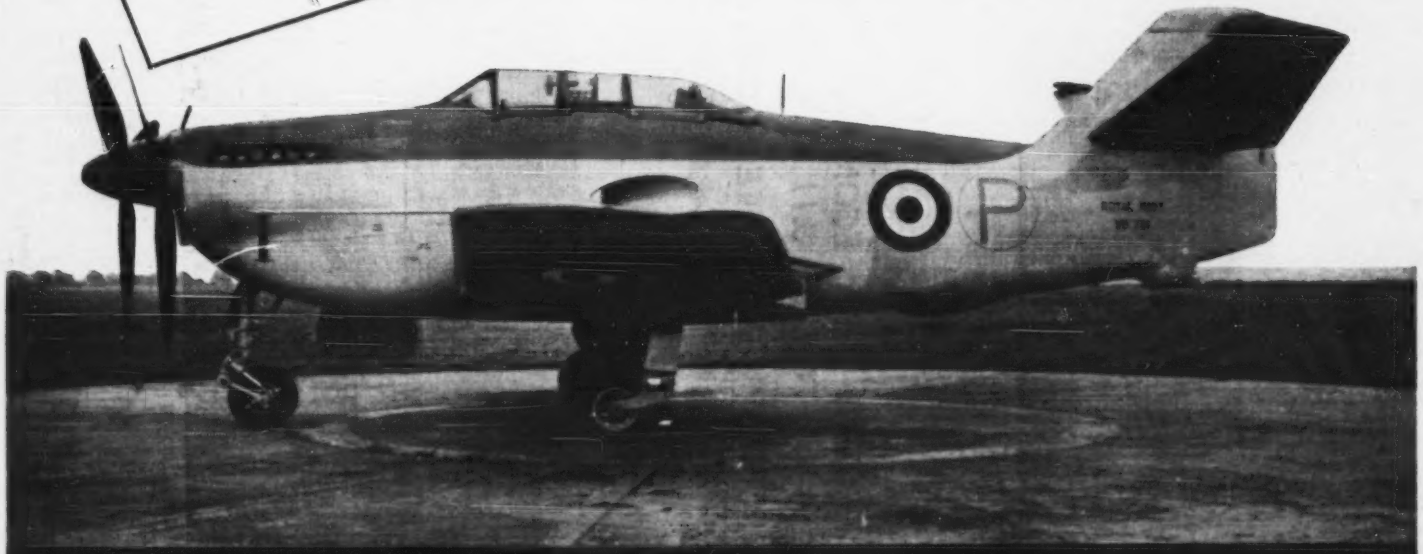
JJ

HABERSHON

HOLMES MILLS · ROTHERHAM

A Naval Prototype

THE Y.A.5 ANTI-SUBMARINE AIRCRAFT



BLACKBURN & GENERAL AIRCRAFT LIMITED, BROUGH, EAST YORKS

Fokker

FOKKER S.11 "INSTRUCTOR" side-by-side basic military trainer with excellent flying characteristics.

FOR EFFECTIVE AND ECONOMIC INSTRUCTION
FOKKER S.11 & S.12

TWO AIRCRAFT ★ ONE CONSTRUCTION
SAME SPARE-PARTS

FOKKER S.12, nosewheel version of Fokker S.11.

ROYAL AIRCRAFT FACTORIES FOKKER
AMSTERDAM

Chosen by the Senior Service

The Percival 'Prince' has been selected by the Royal Navy for communication duties and as a 'flying classroom' for the training of naval aircrew. The single engined performance of either of the two 520/550 h.p. Alvis Leonides engines meets the latest and most exacting operational requirements.

Percival PRINCE

The Prince in its civil version is the most modern 8-12 passenger airliner.

Available also for aerial survey, executive travel, air ambulance, freighting.

PERCIVAL AIRCRAFT LTD.

One of the Hunting Group of Companies.

LUTON, BEDFORDSHIRE, ENGLAND, AND AT TORONTO, CANADA.

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SKYWAYS LIMITED OFFER FOR SALE

with immediate delivery

THREE OF THEIR

55-SEATER SKYMASTER AIRCRAFT

G-AJPM.	TOTAL	HOURS	SINCE	NEW	7736
G-AJPN.	,,	,,	,,	,,	8819
G-AJPO.	,,	,,	,,	,,	10639

The above aircraft are offered with new C. of A. and all engines and components NIL time since overhaul.

•

THE FOLLOWING IS A SPECIFICATION OF THE AIRCRAFT, EACH OF WHICH IS SIMILAR.

Engines. Pratt & Whitney R 2003-7 at present fitted but necessary kits for conversion to -11 have been ordered and are being delivered during the period February-June, 1950. These kits are included in the purchase price of the aircraft.

Cockpit. This is equipped with dual blind flying instruments and most other instruments are duplicated.

Pioneer flowmeters recording flow in lbs. per hour. Oil contents gauges. Sperry A.3 autopilot. P.12 inverted compass. Windscreen wipers. Drift sight. Astro compass mounting. Flight Engineer's seat installed between pilot's. Navigator's seat and table. In this compartment there is also a separate entrance for the use of crew members.

Crew's Rest Quarters. In this compartment are situated two bunks, the bottom one of which is convertible into three seats for supernumerary crew.

One toilet (Elsan) in separate compartment, also wash basin with its own water system.

Radio. This consists of the following equipment :-

Liaison transmitter and receiver. 8 tuning units. One frequency meter. American S.B.A. Fan Marker S.B.A. British S.B.A. V.H.F. 3 Command transmitters and receivers. Bendix radio compass.

Freight Compartments. There is a front freight compartment situated under the floor, with capacity for 150 cu. ft. and another under-floor freight compartment situated aft, with a capacity of 176 cu. ft.

Cabin. The upholstery consists of grey head lining and grey upholstery down to a maroon red kicking strip along the side of the fuselage. The carpets are marroon red as also are the 55 leather upholstered cabin seats. The heating is by two Stewart Warner heaters.

There are two light luggage racks which extend the full length of the passenger cabin, into which are incorporated a reading light and cold air supply for each seat. Each seat is equipped with one R.F.D. type lifebelt. In addition, there is a red upholstered foot hassock for each seat.

At the aft end of the cabin a cocktail bar is installed together with a seat for attendant. If desired two additional passenger seats can be substituted for the cocktail bar.

Galley. On the starboard side of the galley is located a sink complete with draining board and comprehensive array of cupboards and racks. In addition, an electrical urn is fitted for boiling water.

Toilets. There are two toilets, one ladies, one gentlemen, in which there are ample containers for soiled towels, etc. together with wash basins and mirrors, etc.

The toilet itself consists of a patent flush type basin which is a marked improvement on previous types. All deposits from these toilets are collected in two large containers located under the floor which are easily removed via the under-floor rear freight compartment.

General. The power plants are equipped with full anti-icing equipment, that is carburettor and propeller anti-icing. Each power plant and nacelle is equipped with the latest Graviner Skyways Fire Prevention modifications which are approved by the Air Registration Board.

In addition, all power plant fluid carrying pipe-lines are flexible and fireproof.

Fuel Capacity and Oil Capacity.

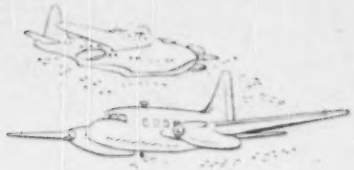
Fuel "B" Wings "E" System.	2321 Imp. Gallons
Oil	111 Imp. Gallons

All-up Weight and Empty Weight.

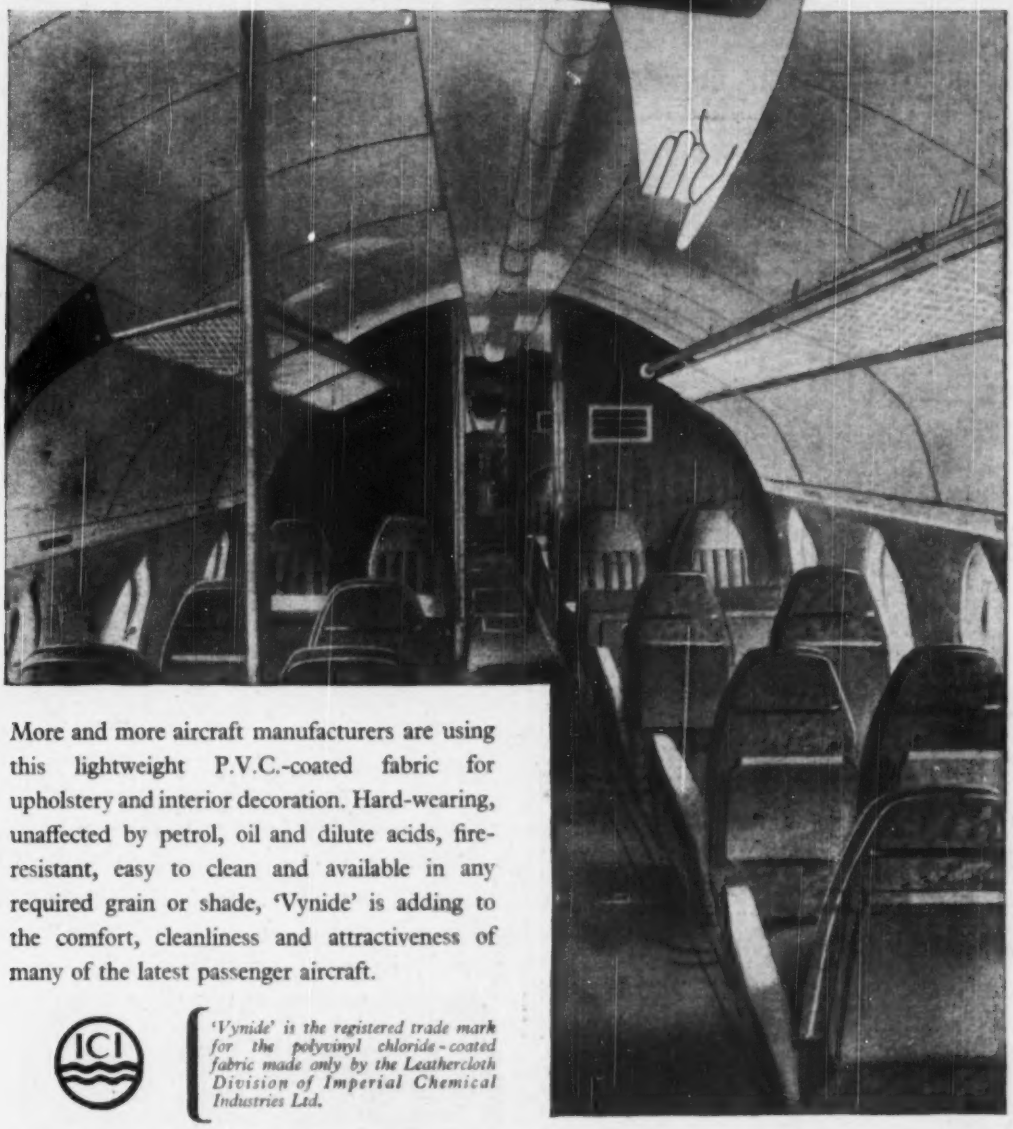
All-up weight	70,700 lbs.
Average empty weight	42,350 lbs.

The aircraft are on view by arrangement at Dunsford Aerodrome.

Skyways Limited. Head Office : 70 Pall Mall, London, S.W.1. Telephone: Whitehall 5771.



HERE'S A PLACE FOR 'VYNIDE' REGD.



More and more aircraft manufacturers are using this lightweight P.V.C.-coated fabric for upholstery and interior decoration. Hard-wearing, unaffected by petrol, oil and dilute acids, fire-resistant, easy to clean and available in any required grain or shade, 'Vynide' is adding to the comfort, cleanliness and attractiveness of many of the latest passenger aircraft.

ICI

'Vynide' is the registered trade mark for the polyvinyl chloride-coated fabric made only by the Leathercloth Division of Imperial Chemical Industries Ltd.

IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S·W·1

BA.343

COMPANY MEETING

HAWKER SIDDELEY GROUP

A YEAR OF SUCCESSFUL OPERATIONS

MR. T. O. M. SOPWITH'S REVIEW

The fourteenth annual general meeting of the Hawker Siddeley Group, Ltd., was held on January 18 in London. Mr. T. O. M. SOPWITH, C.B.E., F.R.Ae.S. (chairman) who presided, in the course of his speech said :

Once again I have the pleasure to report a year of successful operations. Our efforts in the export field have been particularly successful and have accounted for a substantial proportion of the increased trading profits.

In recommending a final dividend of 17½ per cent., making a total of 32½ per cent., less tax, your directors have had in mind the request of the Chancellor of the Exchequer, regarding dividend limitation. I would emphasise that this dividend rate is related to the nominal amount of the Ordinary share capital, whereas, in point of fact, the actual capital representing the equity interest is now more than seven times the nominal value of the Ordinary shares. Your Board propose, as soon as permitted by the Government, to formulate a scheme for bringing the issued Ordinary capital more into line with the real capital employed.

COMMERCIAL AIRCRAFT

This has indeed been a notable year for the British civil aircraft industry which, with its jet and turbo propeller airliners, shows promise of regaining world supremacy. We have played our part in this. Since our last meeting the Armstrong Whitworth "Apollo" and the A. V. Roe Canada "jet-liner" have completed many hours of test and demonstration flying.

The A. V. Roe "Tudor 8," the world's first 4-jet research airliner has also many hours of successful flying to its credit. A further six of these are under construction for the Government, who are to use them for very high altitude research work.

MILITARY AIRCRAFT

The Gloster "Meteor" is still holding its position in the forefront of the world's jet fighters and shows every indication of doing so for some time to come. It is giving good service in five countries. A new and faster model, the Mark 8 "Meteor," is now in full production for the Royal Air Force.

Mention must also be made of the "Meteor 7" Trainer, the only two-seater jet trainer in production outside America.

Hawker Aircraft, Ltd., still have the "Fury" and "Sea Fury" fighters in production and an order has been received from the Royal Navy for the "Sea Hawk." Research continues with their P.1052 swept-back wing experimental aircraft.

A. V. Roe and Co., Ltd., are developing the "Shackleton," a long range maritime reconnaissance aircraft, which has completed most of its tests and will soon be handed over to the Royal Air Force for extended service trials.

The Avro Athena, an advanced training aircraft, is on service trials and a small pre-production batch is almost completed in the factories. A. V. Roe Canada Ltd., have designed a twin-jet long range all-weather high-speed fighter to suit the special conditions of the Royal Canadian Air Force. This is known as the "CF.100." The first prototype is preparing for flight tests at the moment and the first small production batch is now going through the shops.

AERO ENGINE AND GAS TURBINE DIVISION

Last year I referred to the intensive programme of research and development in which the engine division was engaged. This work continues at the same high level of activity and with satisfactory progress. The "Mamba" engine has been developed to higher powers and is incorporated in prototypes of four aircraft. The "Double Mamba," the first engine of its type in the world, has been produced and is flying in a new naval reconnaissance machine. "Python" engine development continues and series production has commenced, the type having been adopted to power a naval strike aircraft. Work is also proceeding on a pure jet engine, the "Sapphire."

"Cheetah" production continues and this remarkable engine has been chosen to power a new basic trainer.

LIGHT ALLOYS

Good results are being achieved by High Duty Alloys, Ltd., in the production of light alloys, not only for the aircraft industry but for an increasing number of other uses.

Factory-built Houses.—A. W. Hawksley, Ltd., have been given authority from the Ministry of Health to make another three thousand houses for this country.

MOTOR-CARS

During the past year, Armstrong Siddeley Motors have introduced a new 18 h.p. car with a much improved performance. This model was made available for the home market in September last.

A special design of body on the 18 h.p. chassis has also been introduced for the overseas market and has been very favourably received, particularly in Australia, Rhodesia and South America.

EXPORT

Our export order book covers various types of aircraft including Meteors, Lincolns, Lancasters, Ansons, Tempests and Furys and in addition motor-cars, houses and diesel engines. Meteors are also being manufactured under licence in Holland for the Netherlands and Belgian Air Forces.

I should emphasise that the 1948-49 profits reflect the outcome of exceptional circumstances in export markets. Competition is becoming keener in these markets and we cannot look for such good results next year.

The Report was adopted.

You too, can leave your WEIGHT problem

Take advantage of the impressive weight saving possibilities which Magnesium can offer in aircraft component design, then add our wide experience of manufacturing technique, and the result—the solution to your problem.

We have made outstanding contributions to weight-saving on many aircraft in service to day, and in each instance the excellent machining and welding qualities of Magnesium have proved once again that it is the ideal structural metal.

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MAGNESIUM

Lighten your load

ESSEX AERO LTD

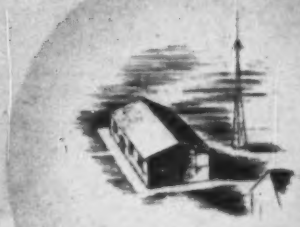
Specialists in MAGNESIUM

PRESSINGS • MACHININGS • WELDED FABRICATIONS

EXPERIENCE SPEAKS..

...in Communications Equipment by Plessey

The crystal set era and the early days of valve amplifiers seem long ago. Yet even then, Plessey was a respected name in radio. Plessey experience in the field of electronics is probably unequalled. That experience produced well over 160,000 major electronic and communications equipments during the war years. And it all adds up to this: that for a first-class product in the field of communications equipment, it is a good policy to remember Plessey.



CEI

AN IDEAL VHF TRANSMITTER-RECEIVER FOR TRAINERS

The Plessey P.TR.61 VHF Transmitter-Receiver has been designed for ease of operation and is ideal for light or trainer aircraft.

Note these points:

- Frequency range 116-132 Mc/s. ● Can be operated with one hand.
- Fully tropicalised. ● MCA type approved.
- Total weight 14.6 lb. Consumption 55 watts.
- Six pre-set crystal-controlled channels. ● Any additional number of channels are available by simple crystal changing in flight.

Illustrated brochure (Publication No. 316) is available. Write also for brochures describing the Plessey range of GROUND *Aeronautical Equipment.*

THE PLESSEY COMPANY LIMITED · ILFORD · ESSEX

MASKING..

QUICKLY and EFFICIENTLY

Quick and easy to apply and easy to remove, leaving no residue . . . "Durex" Masking Tape is an amazing time saver in the paint shop, it is instantly adhesive, tough and flexible, and impervious to Synthetics, Lacquers and enamels.

Supplied in rolls 72 yards long and in a variety of widths.

"DUREX" *Masking* TAPE

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break your bottleneck!

THE MOST *PROGRESSIVE* NAME IN COMPONENT MANUFACTURE

One worry less in striving for an even flow of aircraft production — T. J. BROOKS deliver the components you want — when* you want them.

*In a few hours in an emergency.

T. J. BROOKS (AUTOS) *Ltd.* LEICESTER PHONE 45555

The MARTIN-BAKER EJECTOR SEAT provides for escape—in emergency—at all speeds, and under all conditions. It is the standard seat for the R.A.F.; for all new fighters and bombers; and is also supplied to the principal countries of the world.

MARTIN BAKER

AIRCRAFT Co. Ltd., Higher Denham, Nr. Uxbridge, MIDDX

RUMBOLD

WEIGHT 34 lbs.!

TRIPLE HIGH DENSITY SEAT

A VERY COMFORTABLE CHAIR

ARB APPROVED

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RUMBOLD—ALWAYS ABREAST OF THE TIMES

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THE BRISTOL AEROPLANE COMPANY LTD

and were used on the interior of the

'BRABAZON I'

★

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(BRISTOL & LONDON) LTD., BRISTOL

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Propeller Leadership
. . . WORLD-WIDE

88% of all American-built, Multi-engine Commercial Airplanes are equipped with Hamilton Standard Propellers.

And that figure is increasing, because more and more of the world's great airlines are specifying or converting to these propellers.

An important reason for this is performance — due to superior design. The great majority of airline operators have found they get the most out of their engine-propeller combination when Hamilton Standard propellers are doing the job.

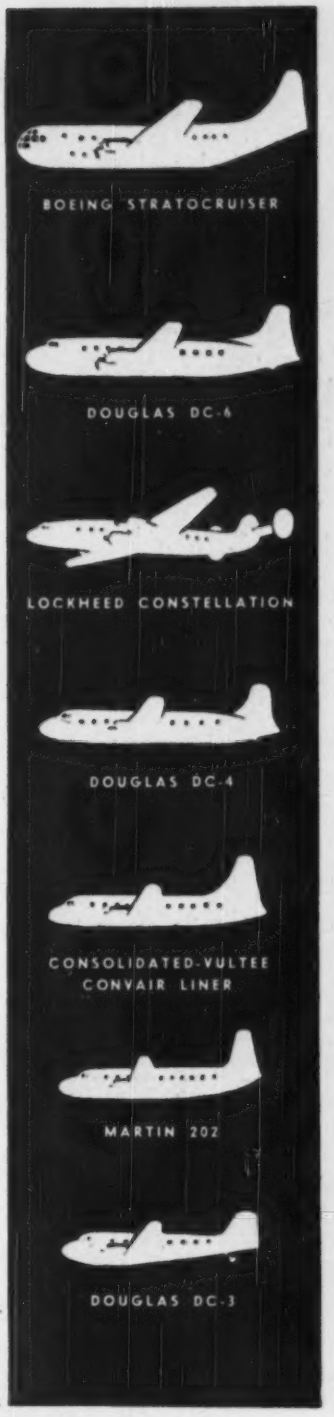
Of equal importance is dependability — due to superior manufacturing. Operators can depend on Hamilton Standard propellers to provide a maximum number of trouble-free hours of service. That means less time in the shop — more time in the air — more profitable operations.

UNITED AIRCRAFT
Export Corporation

EAST HARTFORD, CONNECTICUT, U. S. A.

European Office: 4 rue Montagne du Parc, Brussels, Belgium

PRATT & WHITNEY ENGINES | **HAMILTON STANDARD** PROPELLERS | **CHANCE VOUGHT** AIRPLANES | **SIKORSKY** HELICOPTERS



From all points of view—
Whichever way you look at it—in the air or on the ground—the Boulton Paul Bolliol is a remarkably good aeroplane. In the air its performance is high for its class, its handling qualities are excellent and its manœuvrability is of single-seat fighter standard. On the ground it is easy to control, readily transportable and simple to repair, while the provision in its design for freedom of access for servicing and maintenance is exceptional.

BOULTON PAUL AIRCRAFT LTD.

BPA

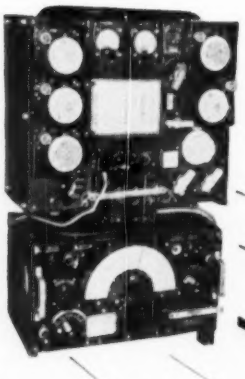
DESIGNERS & CONSTRUCTORS OF AIRCRAFT & ARMAMENT.

DOWTY
Equipped

DOWTY EQUIPMENT LIMITED, CHELTENHAM

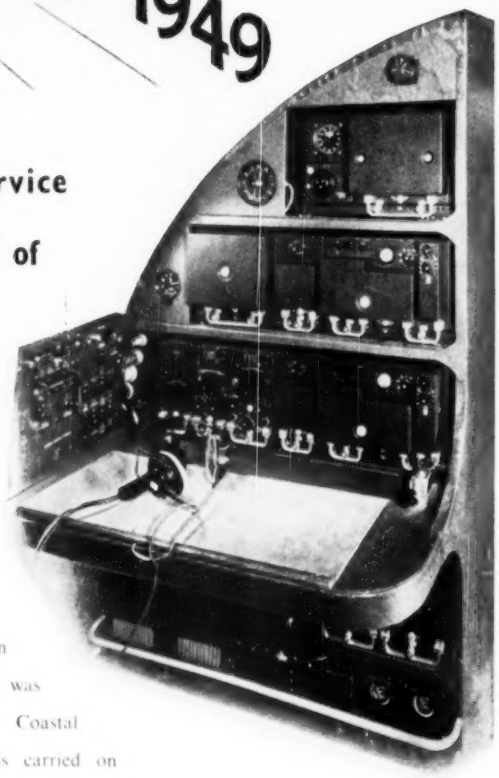
Type AD2

-1939



Type AD87 8882

-1949



Type AD107 108/7092

30 years of uninterrupted service to aviation is the proud record of

Marconi

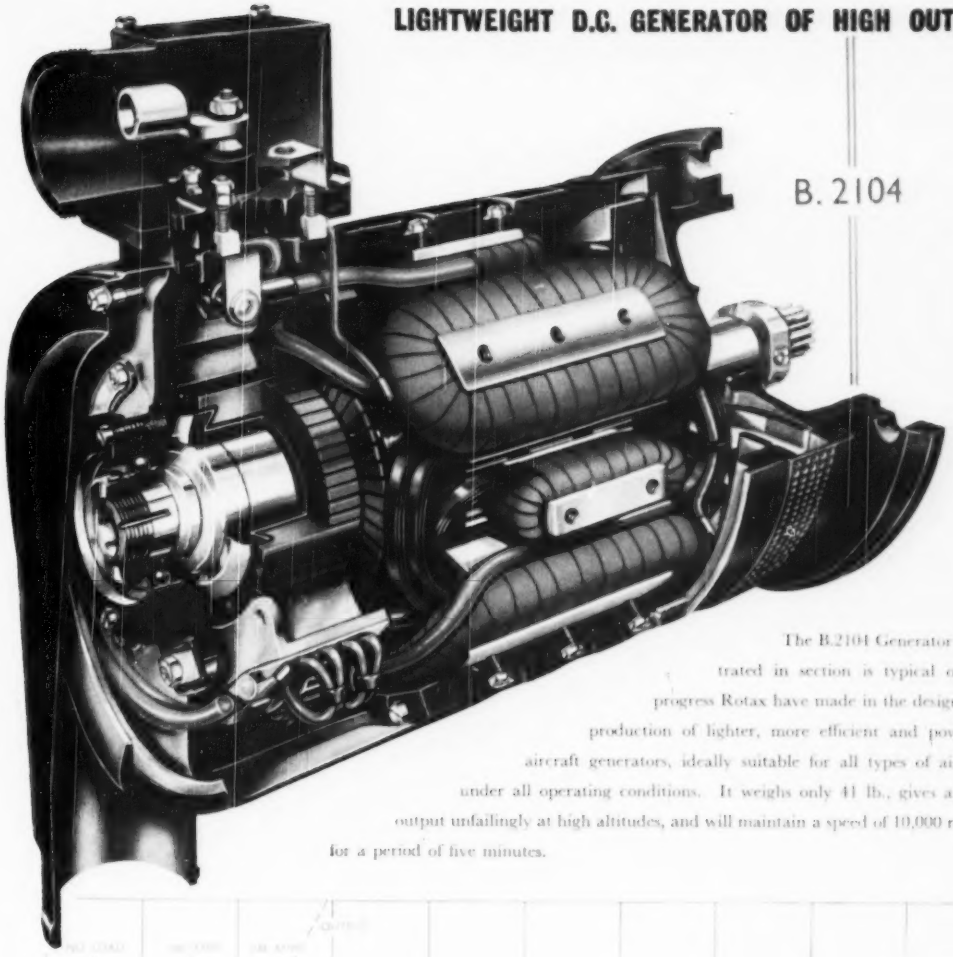
the first name in Air Radio

Ever since the distant days of 1919, Marconi service to aviation has been unceasing. First introduced in 1939 the famous T1154 R1155 set ("The Geep") was installed in every aircraft of the Bomber and Coastal Commands of the R.A.F. This proud tradition is carried on today with the latest Marconi Air Radio equipment illustrated on the right.

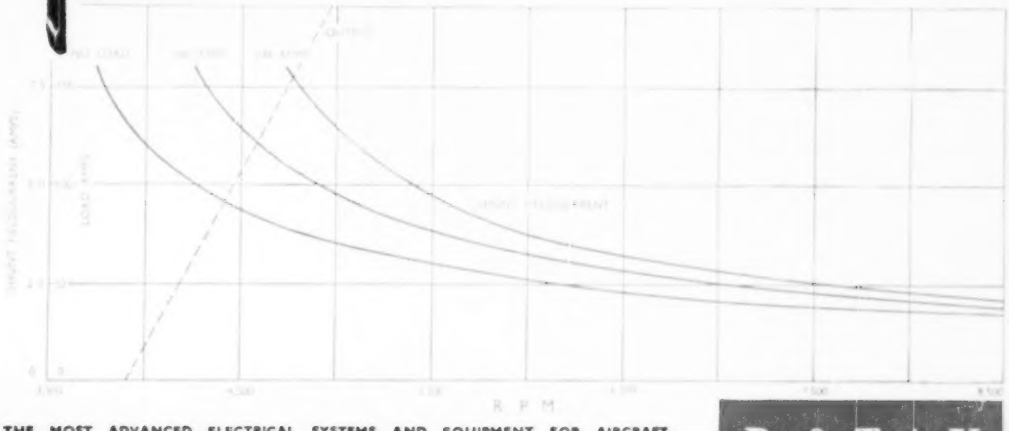
MARCONI'S WIRELESS TELEGRAPH COMPANY LTD., MARCONI HOUSE, CHELMSFORD, ESSEX

LIGHTWEIGHT D.C. GENERATOR OF HIGH OUTPUT

B. 2104



The B.2104 Generator illustrated in section is typical of the progress Rotax have made in the design and production of lighter, more efficient and powerful aircraft generators, ideally suitable for all types of aircraft under all operating conditions. It weighs only 41 lb., gives a high output unfailingly at high altitudes, and will maintain a speed of 10,000 r.p.m. for a period of five minutes.



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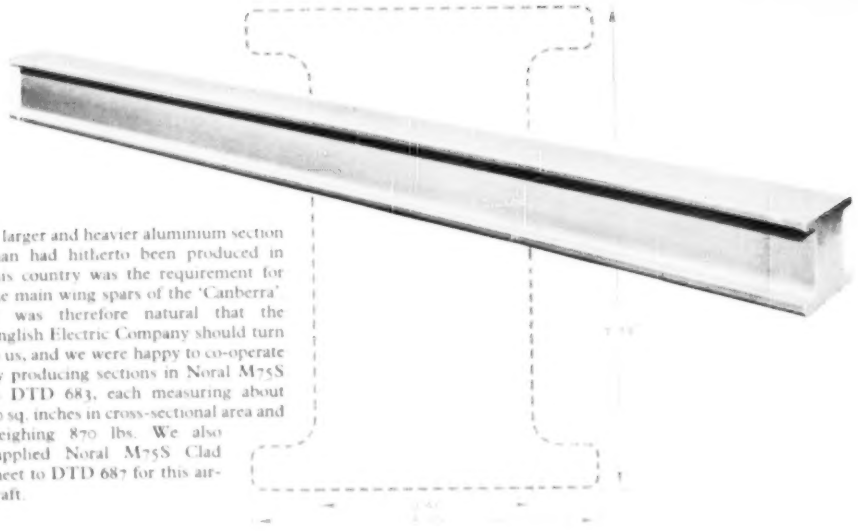
ROTAX LIMITED . WILLESDEN JUNCTION . LONDON N.W.10 . ENGLAND
ROTAX AUSTRALIA PTY. LIMITED . 81 BOUVERIE STREET . MELBOURNE N.3 . VICTORIA
ROTAX CANADA LIMITED . MONTREAL AIRPORT . DORVAL P.Q.

ROTAX

NORAL SPARS



A larger and heavier aluminium section than had hitherto been produced in this country was the requirement for the main wing spars of the 'Canberra'. It was therefore natural that the English Electric Company should turn to us, and we were happy to co-operate by producing sections in Noral M75S to DTD 683, each measuring about 30 sq. inches in cross-sectional area and weighing 870 lbs. We also supplied Noral M75S Clad sheet to DTD 687 for this aircraft.

Northern Aluminium COMPANY LIMITED

MAKERS OF NORAL SHEET STRIP PLATE SECTIONS TUBING WIRE FORGINGS CASTINGS PASTE FOR PAINT

TECHNICAL DEVELOPMENT DIVISION BANBURY OXON SALES OFFICES LONDON BIRMINGHAM MANCHESTER BRISTOL NEWCASTLE-ON-TYNE LEEDS

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MATÉRIEL DE SAUVETAGE POUR L'AVIATION ET LA MARINE

EQUIPO DE SALVAMENTO AERO-MARITIMO

R.F.D. UNIVERSAL LIFE RAFT with pneumatic canopy and inflatable seats gives complete protection from exposure. Capacity 10, 15, 20 and 32 persons. Other types available.

EL BOTE DE SALVAMENTO UNIVERSAL R.F.D. con pabellón neumático y asientos inflables permite obtener una protección completa contra la intemperie. Capacidad para 10, 15, 20 y 32 personas. También hay otros tipos disponibles.

LE CANOT DE SAUVETAGE UNIVERSEL R.F.D. avec toit et sièges pneumatiques offre une protection complète contre les intempéries et la faim. Il peut embarquer 10, 15, 20 ou 32 personnes ; d'autres types sont également livrables.

Aircraft Dinghies
Rowing and Motor Dinghies
Emergency Packs
for
Sea, Desert, Arctic
and Jungle use

Botes Neumásticos para Aviones
Canoas a Remo y Motorizadas
Arneses de Urgencia
para su empleo en el
Mar, Desierto, Artico y en
la Manigua

Canots de sauvetage pour l'aviation
Canots à rames et à moteur
Réserves de vivres pour la haute mer,
le désert, les régions Arctiques,
et la jungle

TYPE 50 JACKET

Life Saving Jackets
Aircraft Weather Covers
Aircraft Flotation Bags
Towed Targets
Balloons, Observation
" Barrage
" Parachute Training

Chalecos Salvavidas
Cubiertas Impermeables para Aviones
Bolsas de Flotación para Aviones
Blancos Remolcados (tiro)
Globos de Observación
" " Barrera
" " Entrenamiento en Paracaidas

Ceintures de sauvetage
Bâches de protection pour avions au sol
Sacs de flottaison pour l'aviation
Cibles pour l'entraînement au tir aérien
Ballons d'observation
" de barrage
" pour l'entraînement de parachutistes

AIR RESCUE AND
SURVIVAL EQUIPMENT
A.I.D. Approval Certificate No. 714352/26

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DESIGNERS & MANUFACTURERS OF
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CATTESHALL LANE, GODALMING, SURREY PHONE: 1444 CABLES: AIRSHIPS

THE LATEST

Safety Harness TYPE 'ZA' 'ZB'- 'ZC'

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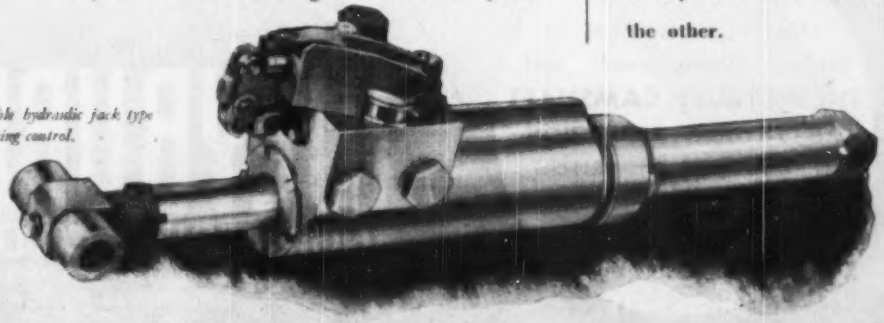

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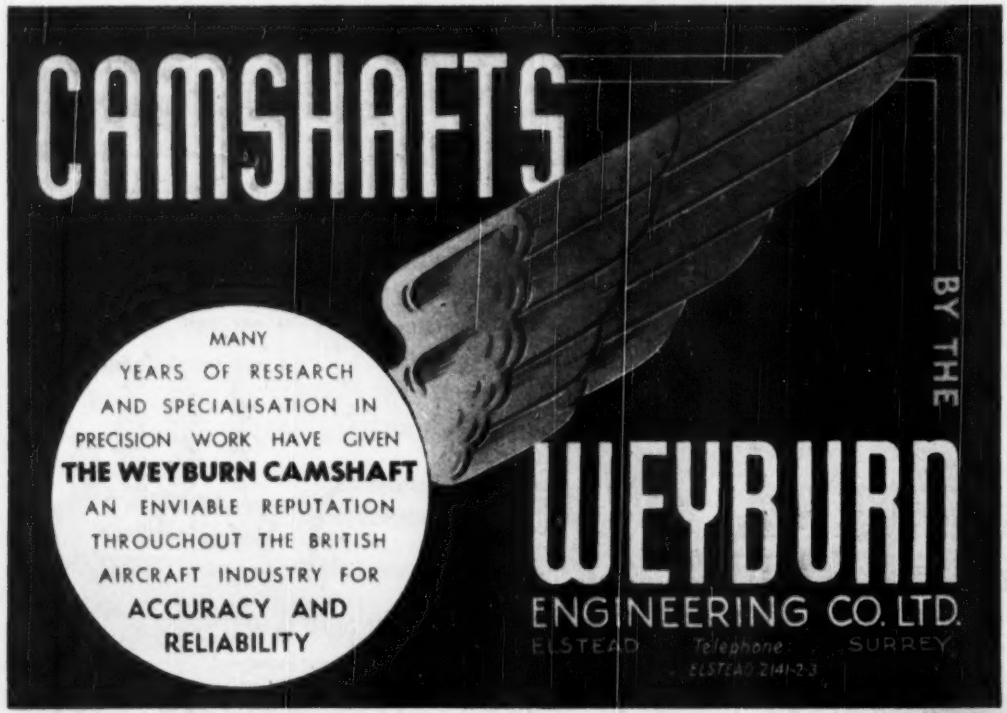
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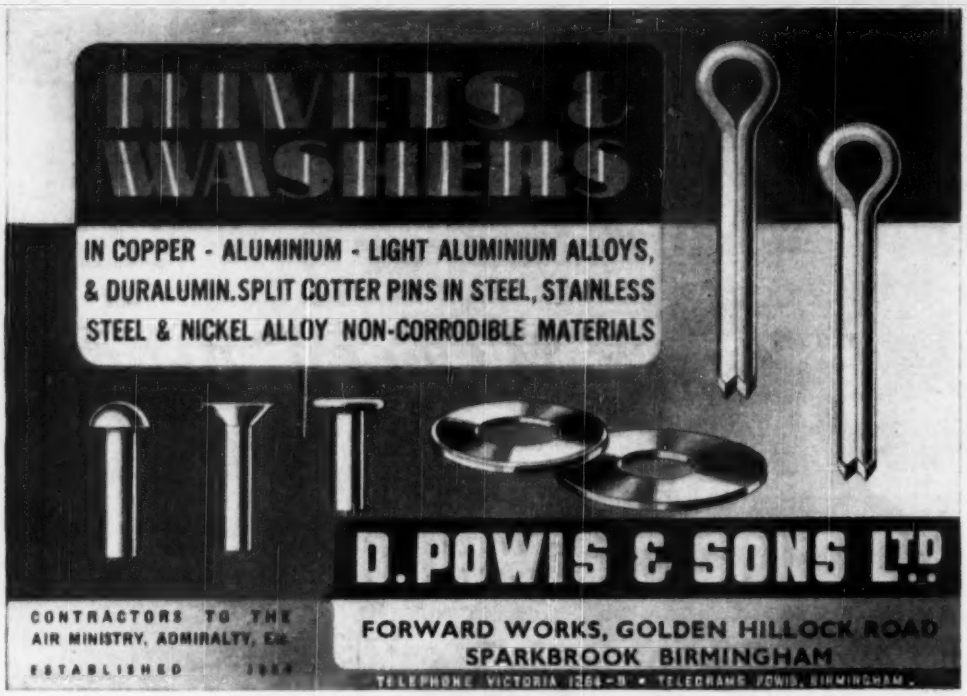
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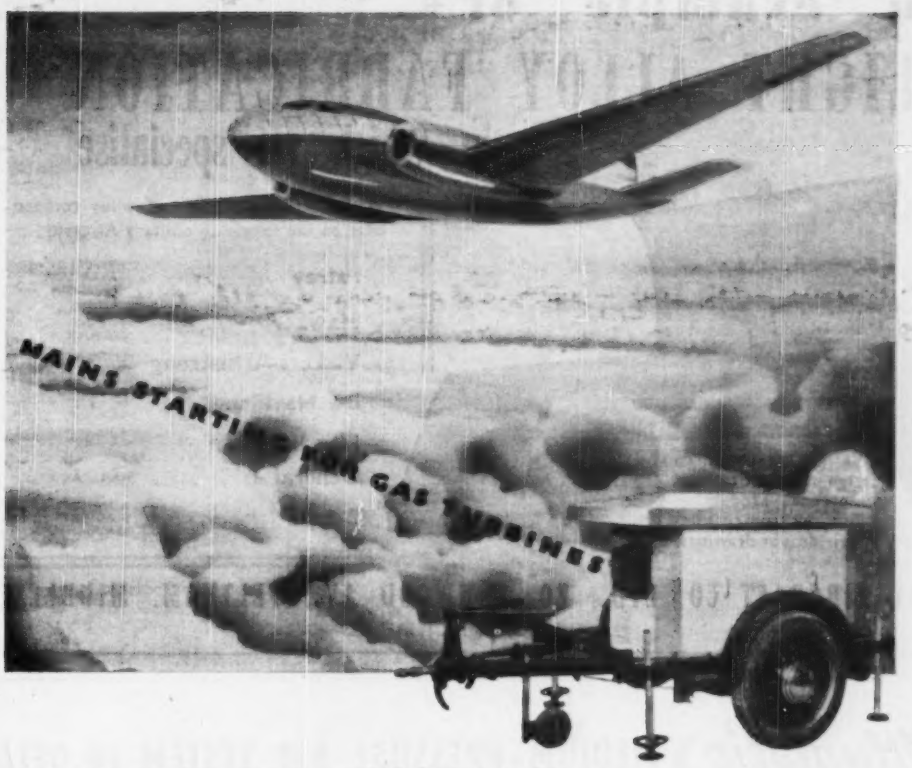

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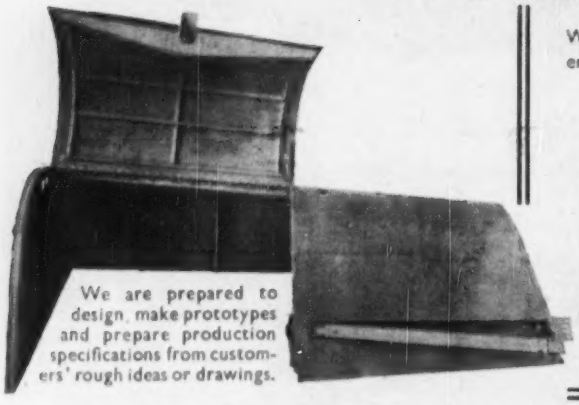

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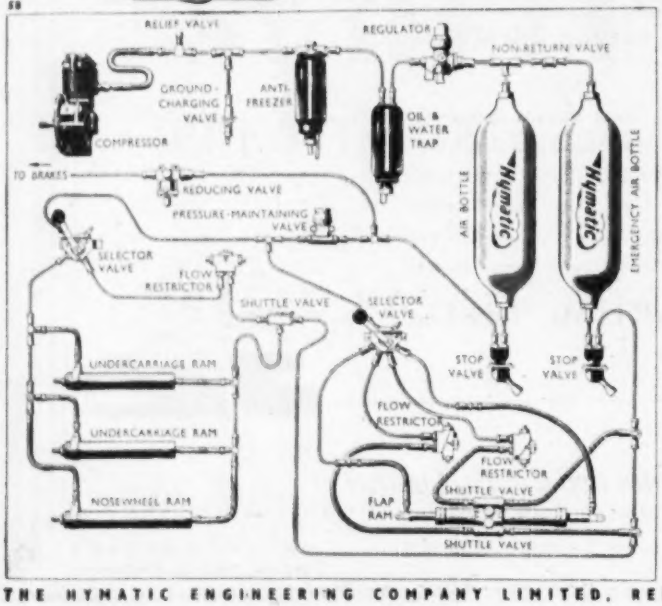

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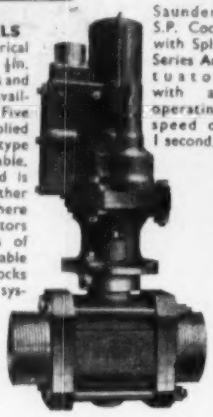

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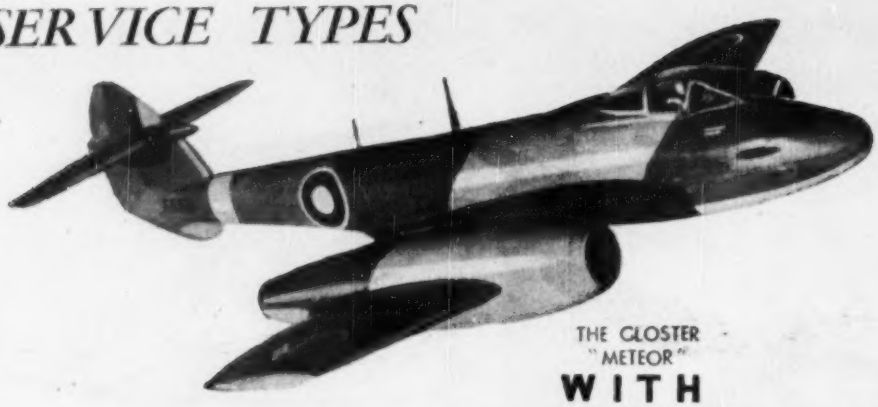

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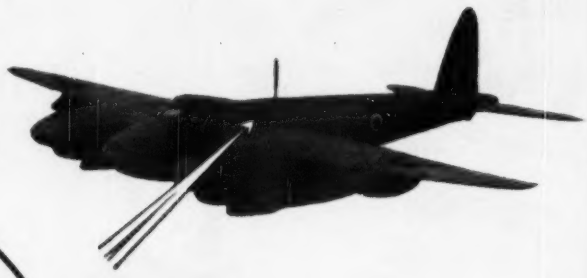

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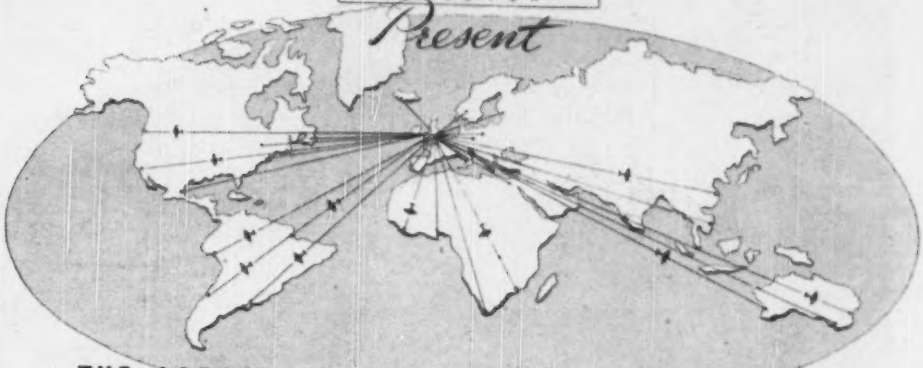

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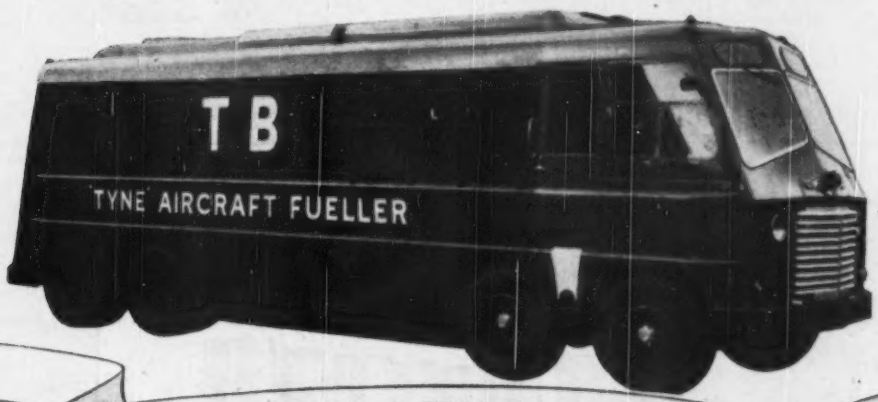

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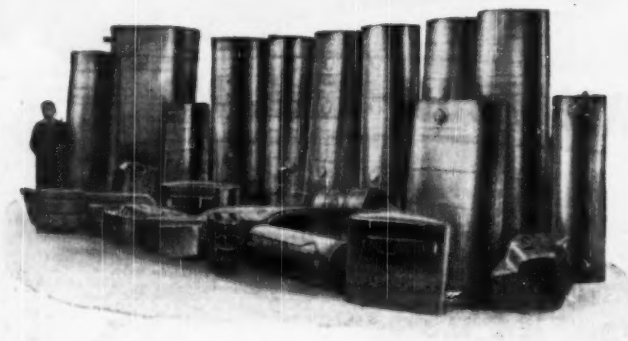

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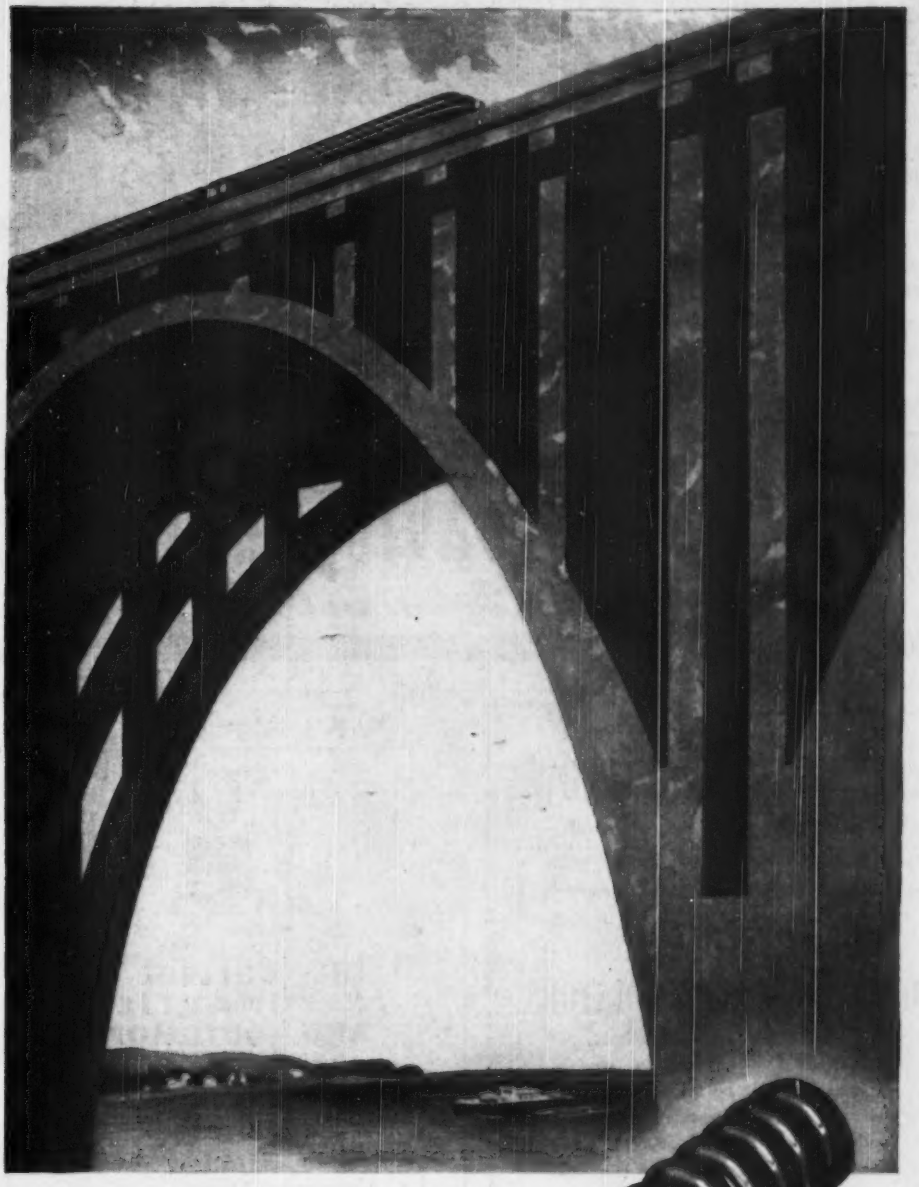

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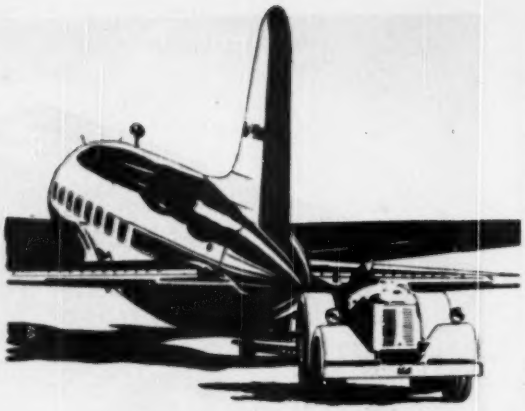

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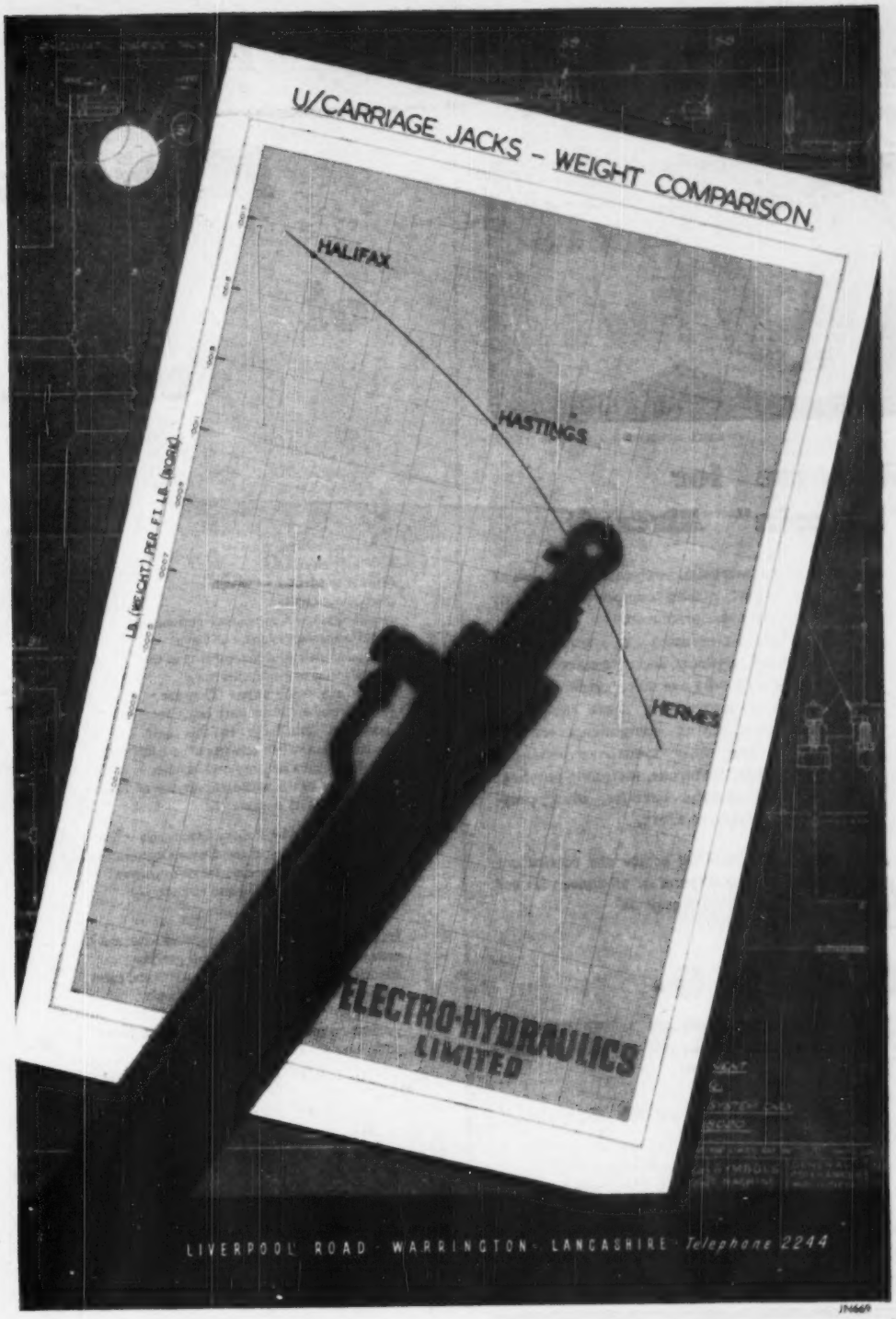
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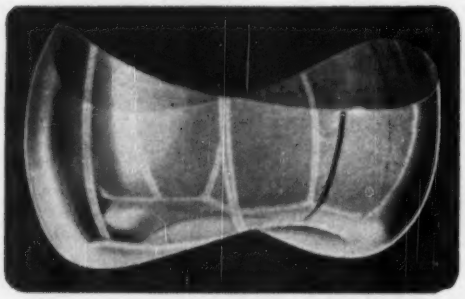

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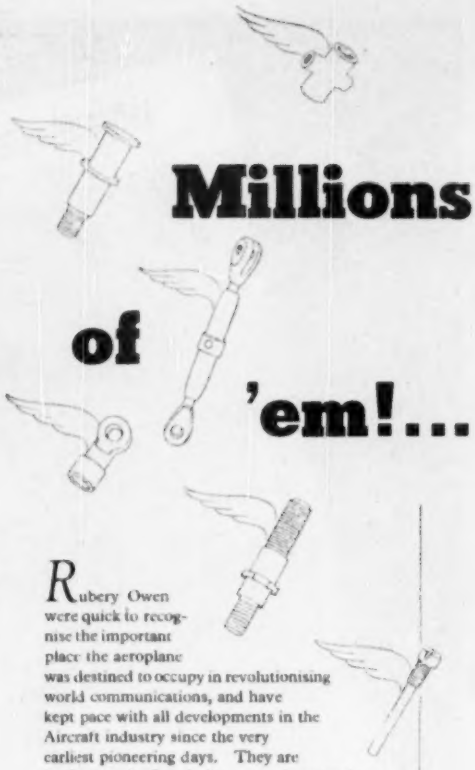

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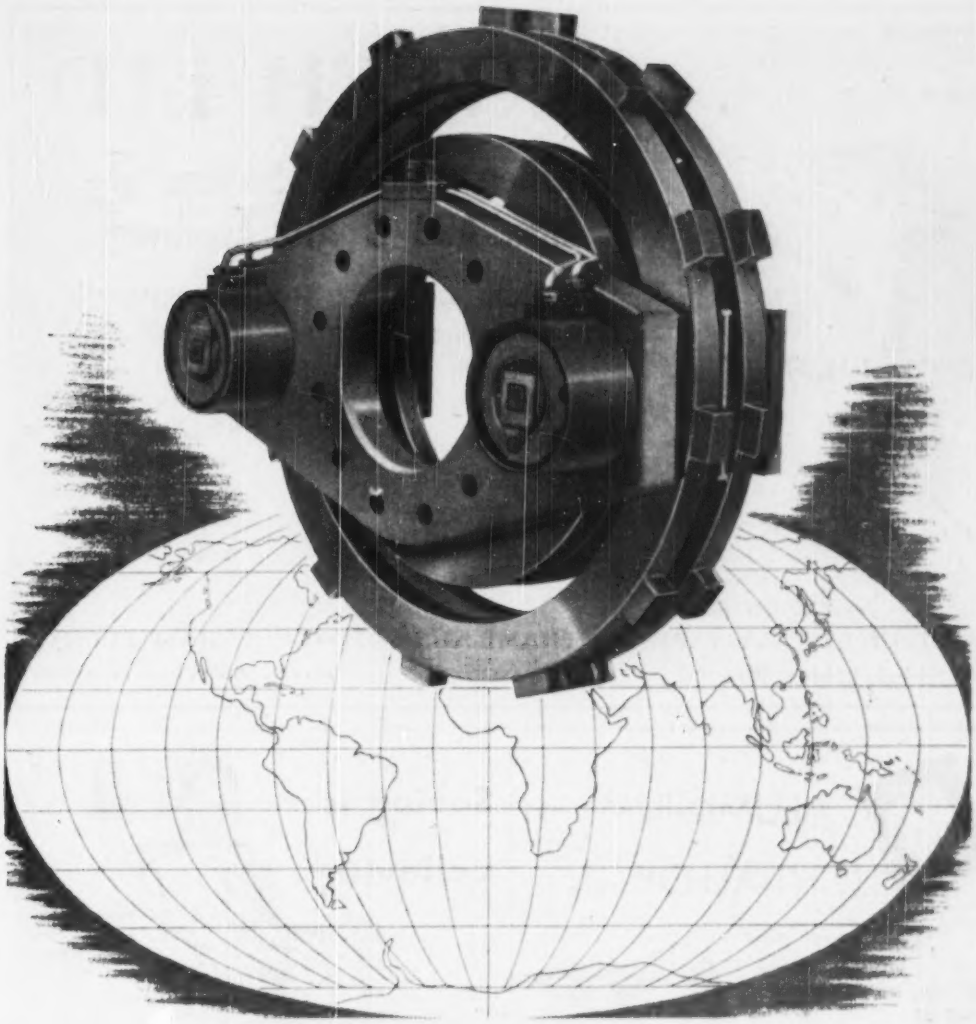

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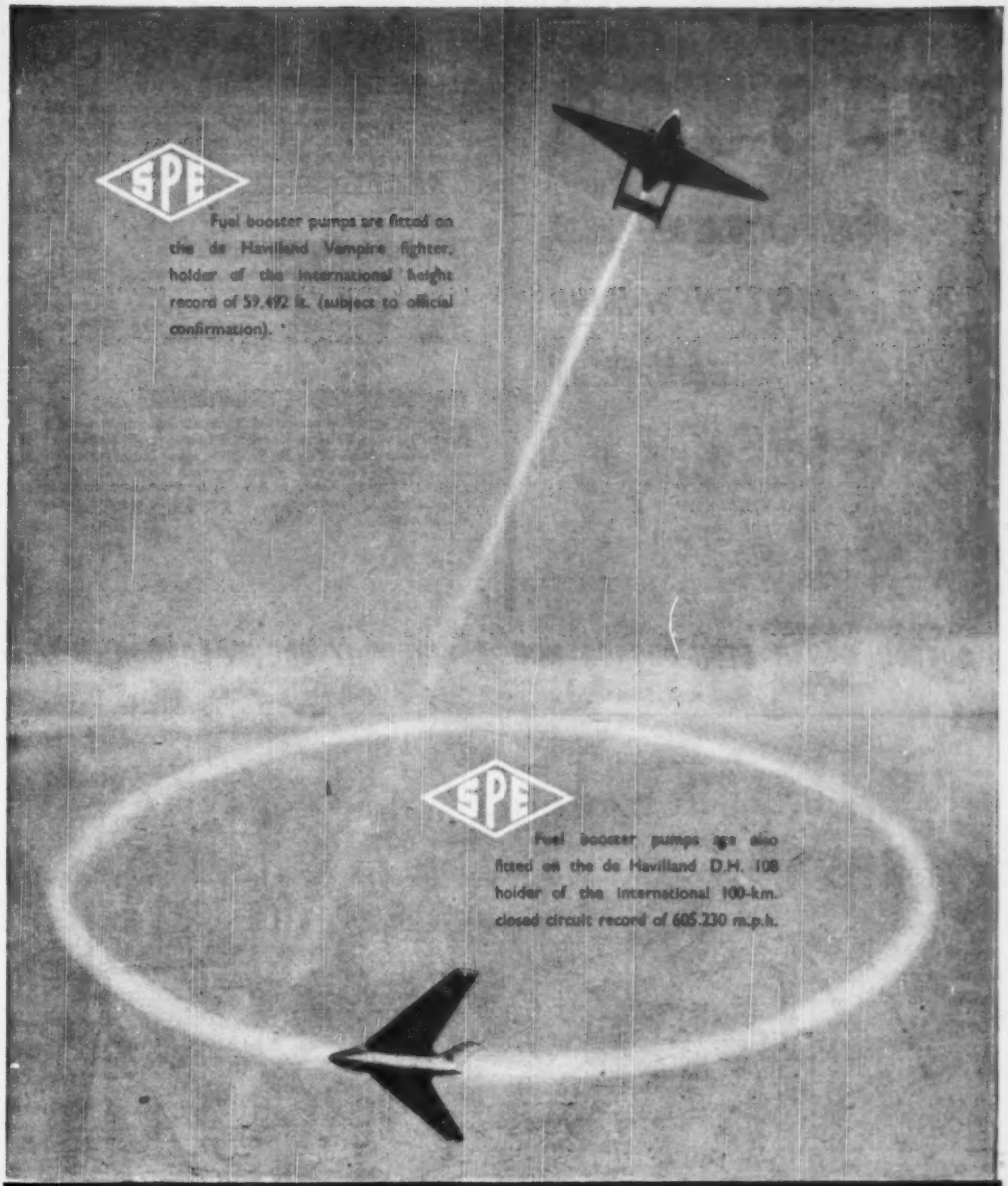
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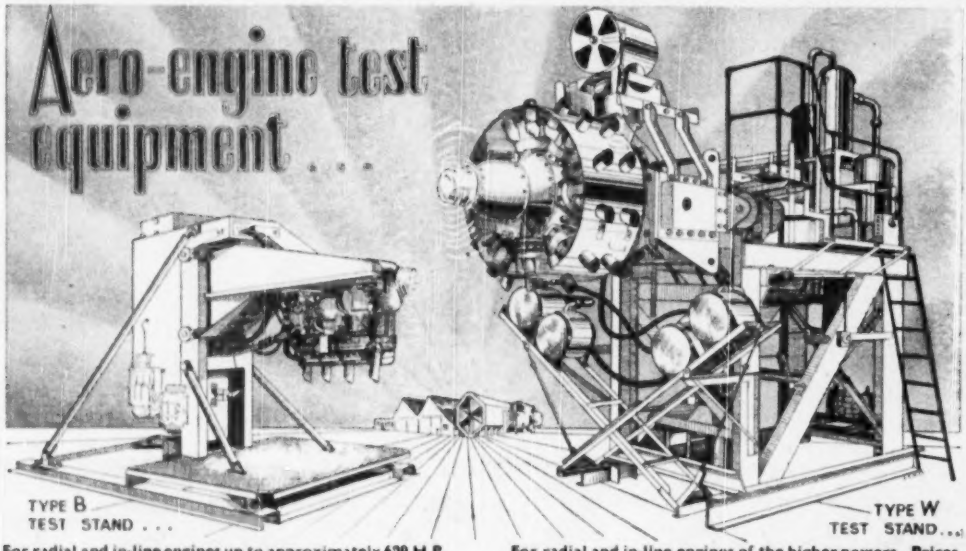

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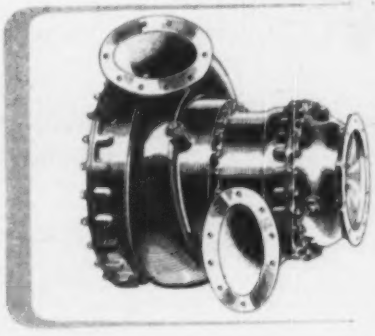

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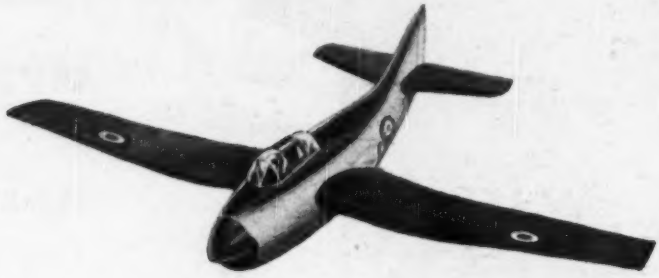

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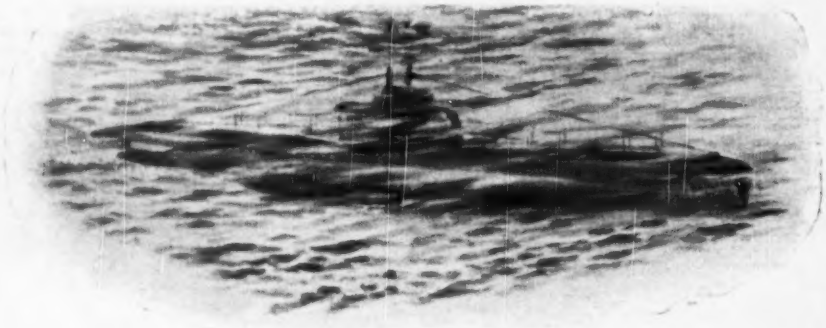

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In Search of Supremacy

THIS issue of *Flight* is mainly given over to a study of the world's military aircraft. Design tendencies and techniques are examined on the basis of the latest and most dependable evidence, and few service aircraft with any claim to consideration can have failed to find a place. The most cursory glance through the pages discloses the diversity of designs now current, and that same multiplicity is symptomatic of the uncertainties and perplexities with which designers and planners are now beset.

Very naturally the reader will seek to draw conclusions concerning British, American and Russian aircraft, but in this he is cautioned to tread warily for, as often intimated in these columns, the meagre information available on Soviet types rarely gains currency in unalloyed state. Even in the few days since the pages constituting our supplement went to press, however, the existence of a new type of Soviet fighter, already in service and of very advanced aerodynamic design, has been confirmed, and a provisional drawing appears on p. 96. There can be little doubt that if adequate thrust is available (e.g. from a Rolls-Royce Nene), such a machine might match, or even excel, the performance of the F-86 Sabre—and before delivery each Sabre is flown at a speed in excess of 670 m.p.h.

Though the diligent student of military flying will be aware that—as is made clear in this issue—achievement of very high speeds may demand the sacrifice of other fighting qualities no less desirable, it must be admitted that the Soviet Air Force and U.S.A.F. have aircraft potentially capable of operating at Mach numbers approached in this country only by experimental types (Hawker P.1052 and Supermarine 510), for which no production order has yet been announced.

Happily, there is no necessity for alarm in respect of the quality of Britain's military aircraft—only for the speed with which the new types are introduced into service, and for the strength of Fighter and Bomber Commands. The problems of finance and manning, with which the Air Staff is grappling to such good effect, are well known, and to ponder these in an issue devoted to flying equipment would be inappropriate; but having digested the contents of our supplement, the reader may well surmise what might be possible if money and man-power were truly sufficient for National defence. He will do well to consider, moreover, that without adequate equipment the finest aircraft might as well remain on the ground.

It is hoped that the present issue of *Flight* will serve not merely as a record and guide, but that it will provide material for meditation at a time when there rests upon everyone some share of the responsibility for safeguarding not only the internal welfare of his nation, but its very existence. At this time, too, we should remember our military obligations to others—obligations which can be met only through strength of arms.

Canada's Contribution

The section of this issue which deals with fighters makes it clear that, of all classes, that most urgently required is the all-weather machine, furnished with the most complete and up-to-date electronic aids. It will be judged, moreover, that such aircraft present severe design problems, and it is especially gratifying, therefore, that the most promising example is the Avro Canada CF 100.

On the occasion of the CF 100's first flight (in the hands of S/L. "Bill" Waterton, of the Gloster Aircraft Company, on January 19th), the Canadian Defence Minister expressed confidence that in this class of aircraft Canada has taken the lead. Certainly, at the present the Mother Country can show nothing comparable, though America, in the Northrop Scorpion and Douglas Skyknight, has types intended for similar duties, though of lower performance.

To Canada, then, must go the credit for having initiated within the Commonwealth the development of a vitally important class of aircraft and one, moreover, which, though first flown with British Rolls-Royce Avon turbojets, has been planned with the ultimate installation of Canadian Orendas in mind.

BEAVER in the AIR

No. 34 of the Series : Qualities of a Specialized Aircraft

By the Editor

AS a cowboy grows fond of his horse so will the Beaver pilot learn to like his aerial mount; both are well prepared to do a special job, both are rugged and reliable, neither is very beautiful. The everyday work-horse of the Canadian rancher bears little resemblance to the *Triggers* of Hollywood, but it willingly gets through a remarkable amount of heavy work at a reasonable speed in all sorts of climates and over all sorts of country, and exactly the same can be said of the Canadian de Havilland Beaver DHC2. It is designed to the specification of the bush pilot, the forest ranger and the charter pilot who serves the mining and lumber camps and is also well suited to other freighting, taxi and communication duties. Ambulance and survey versions have been designed.

Of the sixty-five or so Beavers completed to date the majority are being used on floats, but, should the need arise, wheels or skis can be fitted in a short time.

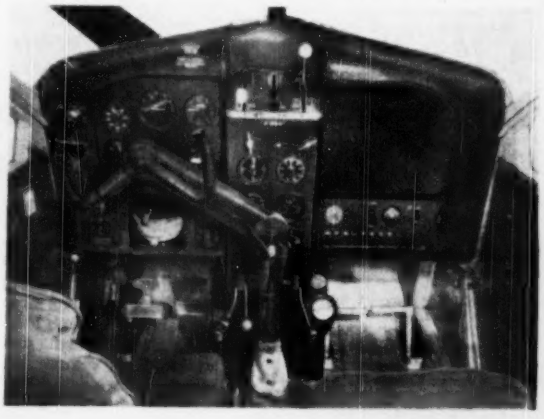
Last week, a perfect winter afternoon and the co-operation of the parent de Havilland company at Hatfield together gave me an opportunity to try out a Beaver under most pleasant circumstances. After a check circuit and demonstration of its remarkable take-off and landing qualities, I took over the first pilot's seat, and with three passengers and full tanks set about getting the feel of the Beaver on the ground and in the air.

First of all there is a superficial likeness to the Harvard centering around the engine—a Pratt and Whitney radial—Wasp in the Harvard, Wasp Junior in the Beaver. The same type of toe operation for the brakes (with pull-to-park knob) is also employed. The essential controls and instruments are simple and economically arranged, though in the main are not grouped. There are quite a few other levers and switches spread about and concerned with cabin heat, carburettor heat, fuel cut-off in case of fire, windscreen defrosting and the priming and starting system.

With the aircraft ready to taxi out, an unmelodious grinding noise indicated that the electrically energized inertia starter was turning, and without hesitation the Wasp Junior fired. It idles smoothly and quietly, and in conjunction with smooth and powerful Goodyear hydraulic disc brakes and plenty of fin and rudder area, handling on the ground is positive and confidence-giving. The pilot's seat is adjustable fore and aft, and a good view is obtained on the ground in spite of the fairly high scuttle. Springing is commendable, and with its reasonably wide track the Beaver sits firmly on its wheels. Float- (with water rudders) and ski-handling are, I am told, likewise good.

Check for take-off calls for almost neutral elevator trim (indicator and control centrally in roof); flaps pumped down to take-off setting (on the indicator on the port wing root)—selector and pump are between the seats; mixture at auto-rich; and, of course, airscrew pitch at fine. The three engine-controls, pitch to port and throttle central, are mounted high in the middle of the fascia panel. Individual winged friction-nuts are found beneath each lever. Electric fuel gauges are provided for the three tanks beneath the floor (total capacity 72 gallons) and the selector cock is on the left-hand side of the blind panel.

In cold weather the carburettor warm-air control should be set to give 32 deg F. The three controls found with this lever below the central engine-instrument panel are the wobble pump, cabin heat push-pull knob, and emergency

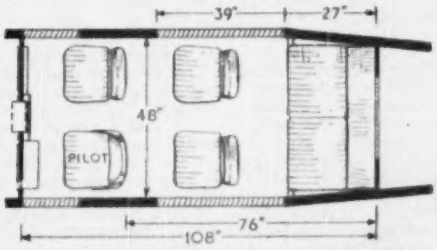


Levers and instruments are plain and accessible and a swing-over control wheel is provided. The magnetic compass, now of the repeater type, has been repositioned in the roof.

The full span of the trailing edge is occupied by interconnected, corrugated flaps and ailerons. There are four entrance doors.

petrol and oil cut-off cock (for use following fire warning). The engine primer is on the floor by the pilot's door.

A 5 to 10 m.p.h. wind was blowing directly across the runway, so on take-off, because of the large tail area and slab sides of the Beaver, a little brake was required to keep straight for the first 50 yards. So rapid was the acceleration, however (and with only 35 inches of boost) that we were airborne in under 200 yards, climbing before I had thought to ease the Beaver off. The aircraft does, in fact, fly itself off astonishingly quickly and is then prepared to climb ahead at all of 1,200 ft/min and a forward speed of about 80 m.p.h. Lower speed gives a better rate of climb still, but may overheat the engine if maintained for long. When raising the flaps one only needs to select—no pumping—and because of the pronounced sink it is best to "milk" them off and perhaps retrim between times.



Dimensions of the spacious seven-seat cabin. Seats are quickly detachable (the rear bench for three folds away) so that a pilot and 125 cu ft of freight can be accommodated.

The tendency at first is to mistrust the steep angle and so climb too nose-down and at too high an air speed.

For normal cruising (wheeled version) a speed of about 150 m.p.h. is attainable, but a wide range of more economical cruising conditions is possible. For very bad weather, with some flap lowered, the Beaver will stooge along with full control at about 65 m.p.h.

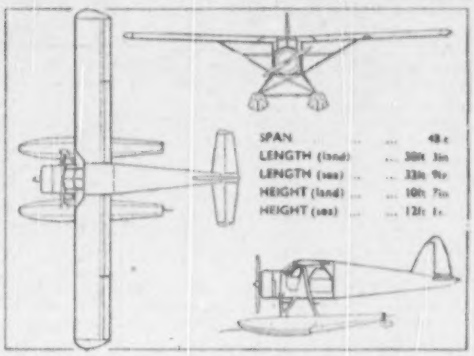
Like the tail form—unexpectedly shapely on an otherwise square-cut austerity aircraft—the light, responsive controls are rather reminiscent of the Chipmunk, the work of the same designer (W. J. Jakimuik, previously with the Polish P.Z.L. company). If anything, the ailerons are too light for the type of machine; however, there is good harmonization and the Beaver can be trimmed to fly hands off for long periods. There is quite pronounced droop on the ailerons when the flaps, with which they are interconnected, approach the fully down position. With flaps and ailerons down, the normal aileron control becomes appreciably softer, but the response is still adequate.

So little use is made of the rudder on the majority of aircraft these days that it is noteworthy to meet one such as the Beaver, which calls for plenty of rudder to go into or come out of a turn correctly.

The stall is unusually docile with or without flap, and at indicated speeds of 40 and 52 m.p.h. respectively (at about 3,000ft) amounts to a gently straight sink, or "mush," preceded by a slight buffeting for warning. Recovery can be effected immediately the stick is released from the hard back (and hard-to-hold-back) position.

When flying around in the Beaver the pilot gets an impression of having plenty of power and unexpected liveliness. The service ceiling of as high as 26,000ft is well above average.

On preparing to approach for landing the pilot finds that the speed drops quickly to 85-90 m.p.h. on throttling back, and flaps can be lowered at any speed below 105 m.p.h. One selects flaps down, looks up left at the indicator, and pumps. There is a pronounced stopping effect, noticeably increased lift and appreciable trim change. In fact, for



comfort on the Beaver one should make plenty of use of the sensitive elevator trimmer, both for change of power and speed and when raising and lowering the flaps.

With pitch at full fine, mixture back to rich from the auto-lean position, and fuel checked, the final approach can commence from near to the runway for, with flaps right down and speed no more than 75 m.p.h., the descent is steep and the view ahead excellent.

A small amount of power at once checks the descent, if need be, and full control remains for the round-out at speeds as low as 60 m.p.h. The Beaver can be felt on to the ground very nicely, and once down shows little tendency to bounce (or swing in a cross-wind). The brakes may be applied quite strongly, early on the landing run, and the aircraft brought to a standstill in about 100 yards with little or no wind to help.

DATA FOR THE D.H.C.1 BEAVER
450 h.p. Pratt and Whitney Wasp Junior

Wing area	250 sq ft	23.25 sq m
Wheel track	10ft 2in	3.1 m
Max. width of cabin door	3ft 3in	1.0 m
Max. height of cabin door	3ft 4in	1.01 m
Landplane tare weight	2,775 lb	1,259 kg
" disposable load	1,875 lb	851 kg
" gross weight	4,650 lb	2,111 kg
Skiplane tare weight	3,022 lb	1,371 kg
" gross weight	4,820 lb	2,188 kg
Seaplane tare weight	3,083 lb	1,399 kg
" gross weight	4,820 lb	2,188 kg
Payload for 200 miles : Landplane	1,435 lb	651 kg
" " Seaplane	1,295 lb	588 kg
Payload for 500 miles : Landplane	1,205 lb	547 kg
" " Seaplane	1,000 lb	453 kg
Max. range with long-range tanks	850 miles	
" speed (s.l.) Landplane	171 m.p.h.	
" " Sea and Skiplane	155 m.p.h.	
Cruising speed (s.l.) Landplane	148 m.p.h.	
" " Sea and Skiplane	131 m.p.h.	
Take-off (s.l.), zero wind, 30 deg flaps	504ft.	
" " " (to clear 50ft)	890ft	

CUMULO-NIMBULAR COMMENTS

More Thoughts About Thunderstorm-flying

By Capt. J. C. Neilan

THE admirable article on "Cu-Nim Gusts" by Capt. D. A. Brice, based on C.A.A. *Aviation Safety Release, No. 304*, is a welcome addition to the almost negligible British bibliography on the practical aspects of flying in thunderstorms.

It is mentioned early on that the trials were made with Black Widow night fighters, and that the great strength of these aircraft, compared with the low factors of ordinary transports, renders the conclusions inconclusive (yes, I'm half Irish!); but there are several points which lead one to consider that the general and so far most-publicized conclusion, viz., "that it was established that no conditions exist in a thunderstorm which of themselves can cause an aircraft to fail structurally," is hardly justified.

The report states that "*apart from a few skin cracks*, however, no structural damage to the machine resulted from this encounter." The italics are mine. Remember—this was a military fighter with factors around twelve, as compared with a transport's modest three to four! Are skin cracks structural failures or not? The answer is that unsatisfactory one—"it all depends." On a transport such as the Dakota, all wing/fuselage stresses may be concentrated in the skin at the wing root. A skin crack here is a structural failure. If gusts in a Cu-Nim can crack the skin of a Black Widow, what will they do to the skin of a Dakota?

THIS article forms a valuable corollary to the contribution by Capt. D. A. Brice, A.R.Ae.S., which appeared in our issue of January 12th. Like the previous author, Capt. Neilan is a commercial pilot of considerable experience and, in addition, has accumulated knowledge of meteorological phenomena from the viewpoint of an expert glider pilot.

The article mentions the highest gust, as opposed to draught, as being measured at about 43 ft/sec, and then goes on to record gusts of +35, −24, +43 and −29 ft/sec, all within five seconds. Surely the measurement of all these gusts should be allied to the time in which they were encountered? It is the acceleration that counts. Taking the last two figures, it is seen that there is an acceleration of 43 + 29 = 72 ft/sec in 2½ sec, which is roughly (pardon the humour!) 2 times *g*. The question then arises—at what air speed were these accelerations measured? Speed sharpens the edge, as it were, and a glider entering these same gusts might experience only ½*g*, while a Comet might experience 6*g*. It may be that these points are dealt with in the report itself, a copy of which I have been unable to obtain.

Unfurnished Accommodation

Before leaving the vexed subject of structural failure, I hope I may be forgiven for bringing into the discussion some personal observations. I remember seeing an Avro XIX of Railway Air Services which landed at Speke after being struck by lightning over the Midlands at about 4,500ft. Both airscrews were split lengthwise, the magnetic compass was "frozen" (possibly "welded" would be more appropriate) on its pivot and would not move, some of the cabin-wall furnishing material was splattered on to the opposite side of the curved ceiling from near the aerial fairlead, and some panels and ribs in the wings were damaged and displaced. The aircraft was out of service for some considerable time. The R/O. said that they ran into the Cu-Nb unexpectedly while flying in layered cloud at their quadrantal height, and the build-up of static was so rapid that there was no time to wind in the aerial.

I have been struck on two occasions, once with aerial wound in, once with it out (again no time to wind it in). In the latter case the compass had to be reswung twice a week for about a month before it settled down. In neither case was any structural damage evident. While effects on the compass have no immediate danger, they might easily lead to an insoluble navigation problem if there be no means of checking the deviation as soon as the Cu-Nb area lies safely behind. I have also heard of a DC-4 having a hole five inches across burnt through its tailplane.

To get back to Capt. Brice's most interesting article. The report gives "draught" measurements of up to 100 ft/sec. This is a lot. It is no less than 6,000 ft/min. At this rate the normal "safety height" allowance of 2,000 ft above the highest ground will be lost in 20 sec. Maybe the airlines ought to double that margin in future! The report states that at no time was the loss of height in a downdraught more than 2,000ft. But this is merely a matter of how long you are in the downdraught. If a Black Widow enters a downdraught at 180 m.p.h. and loses 2,000ft, a Dakota entering the same downdraught at 120 m.p.h. (having reduced speed to minimize the risk of structural failure) will lose 3,000ft. Your fast aircraft suffers smaller changes of height at the expense of more severe accelerations, your slower one has a more comfortable (or less uncomfortable) ride, but loses more height in the downcurrents. The report states that at no time did a downdraught extend below cloudbase. Elsewhere it is mentioned that none of this flying was done below 6,000ft. *Nice* Cu-Nbs! I wish the ones I meet had their bases above 6,000ft. It is usually more like 1,600ft in my experience; and, as most glider pilots who have come near them can testify, there's plenty of downdraught underneath the windward side, in the rain area, right down to the ground. To set against that, it is usually found that the downcurrents are weaker than the upcurrents, but they often cover a greater area.

Instrumental Shortcomings

The remarks about gyroscopic instruments not toppling during these trials makes me envy the Americans their instruments. The British manufacturers had to lower the standards of performance in the panic for increased production during the war. As a test pilot I remember one period when my department had to turn down something like 25 per cent of the gyroscopic instruments fitted to our production aircraft because they did not even come up to the lowered standards. My experience of post-war civil aircraft leads me to believe that in some cases these inferior instruments are still in use, and one's confidence that they will stand up to flight through a thunderstorm without toppling is therefore small, and the only safeguard lies in duplication. The M.C.A.'s introduction of the Instrument Rating to ensure a high standard of instrument flying will be of little use if the instruments do not conform to the same high standard.

Capt. Brice's summary of this report is an interesting document. It is to be hoped that other pilots or meteorologists who have any practical "gen" to add on the subject of flying through thunderstorms will do so through the pages of *Flight*. Let's have some more enlightenment! Can the British Gliding Association or those few courageous souls who have aspired to their "Gold C" heights in Cu-Nb add anything to the material published so far? Are the B.E.A.C. gust investigations getting near the report stage?

We owe a debt of gratitude to the crews who have undertaken the task of investigation, and are thankful for their survival, but we are still left in doubt as to the wisdom of "pressing on regardless" in airliners. There is only the memory of some of our fellow-pilots who were never able to tell us what happened.

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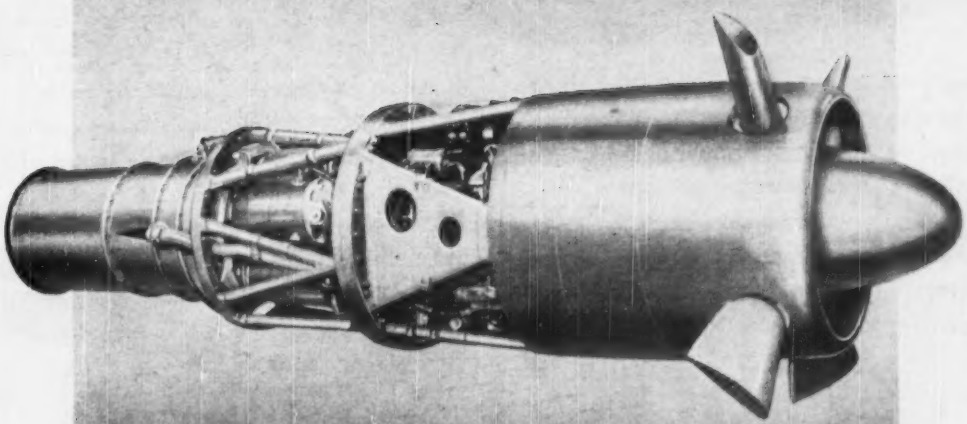
WEIGHT — 1095 LBS.

DIAMETER — 28 INCHES



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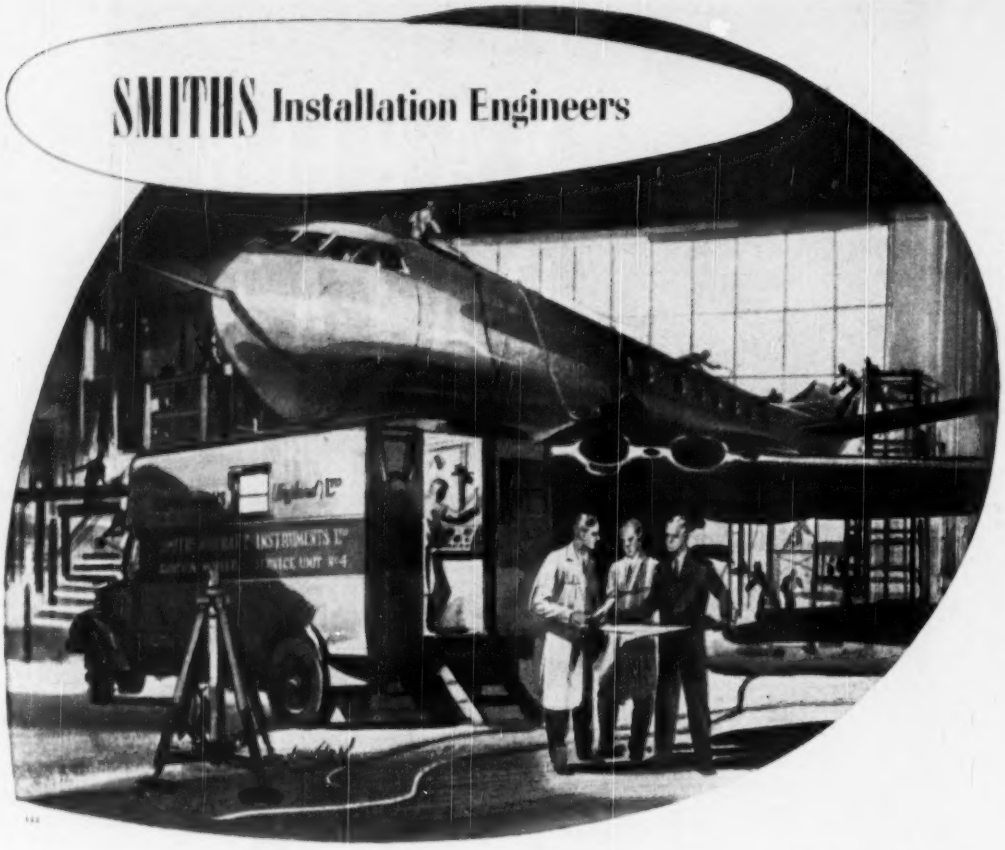

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HERE and THERE

Another N.Z. Race Entry

A PROVISIONAL entry from K.L.M. has been received for the 1953 England-New Zealand air race. The type of aircraft is not mentioned. K.L.M. operate Constellations and DC-6s and have shown a marked interest in the Comet. Both B.E.A.C. and B.O.A.C. have indicated their intention of entering. In the 1934 England-Australia race a K.L.M. Douglas DC-2 was second at an average speed of 168.03 m.p.h.

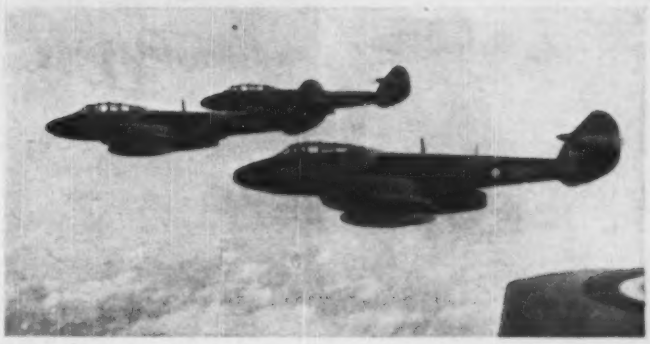
Brancker Memorial Lecture

AS we go to press it is learned that the Brancker Memorial Lecture of the Institute of Transport (originally arranged to take place on February 13th, as listed in "Forthcoming Events" on p. 146) has been postponed until Monday, April 3rd. A. V-M. D. C. T. Bennett, who is to deliver the lecture, will be occupied with election engagements—he is standing as the Liberal candidate for Norwich North.

Continental Training Flight

THE first of its kind to be organized by a civil organization since the war, a navigational training flight over several Continental countries is being made this week by an Anson of Air Service Training, Ltd. On board are A.S.T. instructors F/L. P. F. Middleton and F/L. A. Palmer, and their students are W/C Aly Abou El Gheit (commander of King Farouk's personal flight), W/C. M. Aboul-Ezz and S/L. A. M. Attalla, all of the Royal Egyptian Air Force.

The Anson, which is fitted with overload fuel tanks, is following a route *via* Paris, Nice, Valencia, Tangier, Valencia, Nice, Zurich, Amsterdam, and so back to Hamble.



DANES IN DISGUISE: Week by week the number of British jet aircraft in service with friendly foreign powers increases. Here are seen three Meteor 7s (Rolls-Royce Derwent 5s) for jet training in Denmark. Unlike examples in R.A.F. service, these trainers are camouflaged. It will be noted that they also carry drop tanks.

I.Ae.S. Annual Meeting . . .

DURING the past week the American Institute of the Aeronautical Sciences has been holding its 18th annual meeting in New York.

At the Honours Night Dinner on Monday, the 1949, president, Mr. William A. M. Burden, handed over office to Mr. James H. Kindelberger, chairman of North American Aviation, Inc. Honorary fellowship was conferred upon Dr. Jacob Ackeret, of Zurich, for work on problems of propulsion at high speeds, and on Mr. Arthur E. Raymond (vice-president, engineering, Douglas Aircraft Co.) for his part in the development of the DC-2, 3 and 4 and 6. Of nine Institute fellowships presented, one (to which reference was made last week) was to Mr. A. E. Russell, chief designer of the Bristol Aeroplane Co., Ltd., and another to Mr. J. G. Green, deputy director-general of the Canadian Defence Research Board.

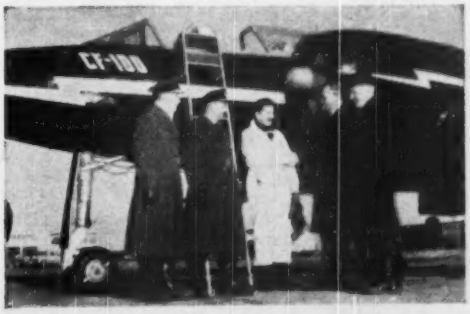
. . . and Special Awards

A SPECIAL I.Ae.S. certificate was presented to Mr. Jerome Lederer, director of the Flight Safety Foundation, for his special contributions in this field. The Robert M. Losey Award goes to Mr. William Lewis of the U.S. Weather Bureau, for research work on aircraft de-icing; Mr. Alexander Flax, head of the Aerodynamic Research Department of Cornell Aeronautical Laboratory receives the Lawrence Sperry Award for "Significant additions to the methods available for determining dynamic behaviour of aircraft, helicopters and missiles"; Dr. Arnold D. Tuttle, medical director of United Airlines, is the first active medical practitioner to receive recognition in the form of the John Jeffries Award; and Mr. George S. Schairer, Boeing's engineer in charge of aerodynamics and power plants, gains the Sylvanus A. Reed award for his development work on such types as the B-29, B-50 and B-47.

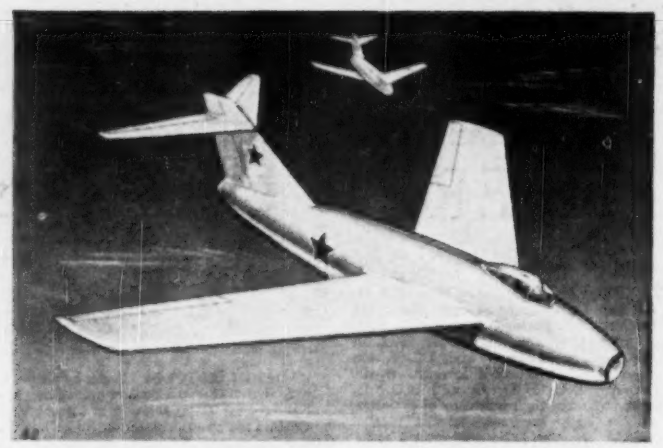
Hawker Siddeley Progress

PRESENTING his report at last week's annual general meeting of the Hawker Siddeley Group, Mr. T. O. M. Sopwith summarized notable progress in several fields. He announced that the Hawker Sea Hawk has been ordered for Naval Aviation, and that construction of the first production batches of the Avro Shackleton (the prototype of which will shortly be handed over to the R.A.F.) is well advanced.

The Armstrong Siddeley Python



MALTON PRIDE: Last Thursday, January 19th, the Avro Canada CF-100 all-weather fighter made a successful first flight at Malton, Toronto, in the hands of S/L. "Bill" Waterton, Hawker Siddeley Group test pilot. The CF-100 has two Rolls-Royce Avons and is thus more powerful than any other British fighter. In the group, photographed after the flight, are A.V.-M. A. L. James, R.C.A.F., Air Marshal W. A. Curtis, Canada's Chief of Air Staff, Bill Waterton, Mr. Brooke Claxton, Minister of National Defence, and Mr. W. N. Deisher, vice-president and General Manager of Avro Canada.



RAKISH RUSSIANS: The new Soviet single-jet fighter illustrated above first appeared at the 1949 Moscow Air Display, and is reported to be in limited service with the Soviet Air Force. Its general layout, with swept-back surfaces and straight-through induction, is not unlike that of the North American Sabre, although the high-set tailplane is a distinguishing feature. By comparison (left) is a research type seen at the 1948 Display; it has fuselage-side intakes and sharply tapered swept wings.

HERE AND THERE

turbojet is in series production; and the Avro Canada Orenda pure-jet unit has proved remarkably successful in bench-tests. Further Orenda testing will be undertaken in a Lancaster and a North American F-86.

Startling Report

AT airfields in all parts of the world, aircraft operators have encountered the menace of bird flocks; although many counter-measures have been experimentally adopted, the problem has by no means been solved. The R.A.F. has employed hawks at several stations, but, as yet, no definite assessment of the results obtained has been announced. At Prestwick, high-frequency radio beams, inaudible to human ears, have been tried. Much research work, too, has been done on bird-proof windscreens.

News of a further method of driving away birds comes from Elmdon, Birmingham, where, it is reported, "explosives similar to fireworks, fused to detonate every 30 minutes," are being placed round the airfield. Given sufficiently loud explosions, the system sounds capable of causing human, as well as avian, evacuation of the Elmdon area.

Sapphires in the Air

THE list of the varied types of "flying test-bed" produced in Britain forms an impressive record of turbojet and turboprop development in recent years. Yet another addition to the record came on January 18th, when the Sapphire-Lancastrian made a successful first flight. Air Service Training, Ltd., who were responsible for the Mamba-Lancaster installation, also undertook adaptation of the latest test-bed type, which has two Armstrong Siddeley Sapphire turbojets in place of the outboard Merlins.

Details of the Sapphire are restricted, but it can be said that it is Britain's—and probably the world's—most powerful turbojet, although in this early stage it is probably flying in de-rated form. The fact that it has flown, however, indicates successful completion of many hours' bench-testing. Armstrong Siddeley assumed complete responsibility for development of the Sapphire from its original designers, the Metrovick Company, several months ago. F/L. Peter Fowler made the first flight from Hamble, landing at Boscombe Down 29 minutes later.

Testing New U.S. Fighter

THE holder of the world's speed record (670 m.p.h.), Major Richard Johnson, is to be test pilot in charge of "phase two" performance trials of the Republic XF-91 interceptor at Edwards Air Force Base, Muroc, California. One of the most interesting American jet fighters, the XF-91 has swept-back wings with reverse taper, variable incidence and leading-edge slots; its power unit is a 5,200 lb-thrust J-47 axial turbojet, supplemented by afterburning and four rocket units in the tail (the third source of power has not yet been used).

The XF-91's initial flight-test programme began last May and has comprised 40 flights.

Slow-flying characteristics of the new fighter are particularly interesting: stall approaches on the XF-91's first flight proved too slow for the "monitoring" aircraft (probably a Lockheed F-80).

NEWS IN BRIEF

MR. JAMES HOWARD KINDELBERGER, chairman of North American Aviation, Inc., has been appointed 1950 president of the Institute of Aeronautical Sciences. He succeeds Mr. W. A. M. Burden, former U.S. Assistant Secretary of Commerce for Air.

* * *

Mr. Desmond F. Hannan has joined the staff of Aircraft Materials, Ltd., Midland Road, London, N.W.1, as head of the technical sales department.

* * *

"In order to prevent disappointing stair-climbs," R. K. Dundas, Ltd., announce that, having outgrown their long-established St. James's Street address, they have moved into larger offices at 29, Bury Street, St. James's, London, S.W.1. The telephone number (Whitehall 2848) remains unchanged.

* * *

Young men contemplating radio and radar engineering courses will find much useful guidance in two finely illustrated brochures, *Marconi Training* and *Marconi College*, published by the Education Department (Arbour Lane, Chelmsford, Essex) of Marconi's Wireless Telegraph Co., Ltd. Training facilities at the college are available to young engineers joining the company and to nominees of associated companies and of clients.

AS THEY WERE: In *Wonder Jet*, a 20-minute Central Office of Information film of jet-propulsion development, A. Cdre. Sir Frank Whittle and Mr. W. E. P. Johnson (left), now managing director of Power Jets, appear briefly as themselves in 1926—respectively, a flight cadet and his instructor at the R.A.F. College, Cranwell.

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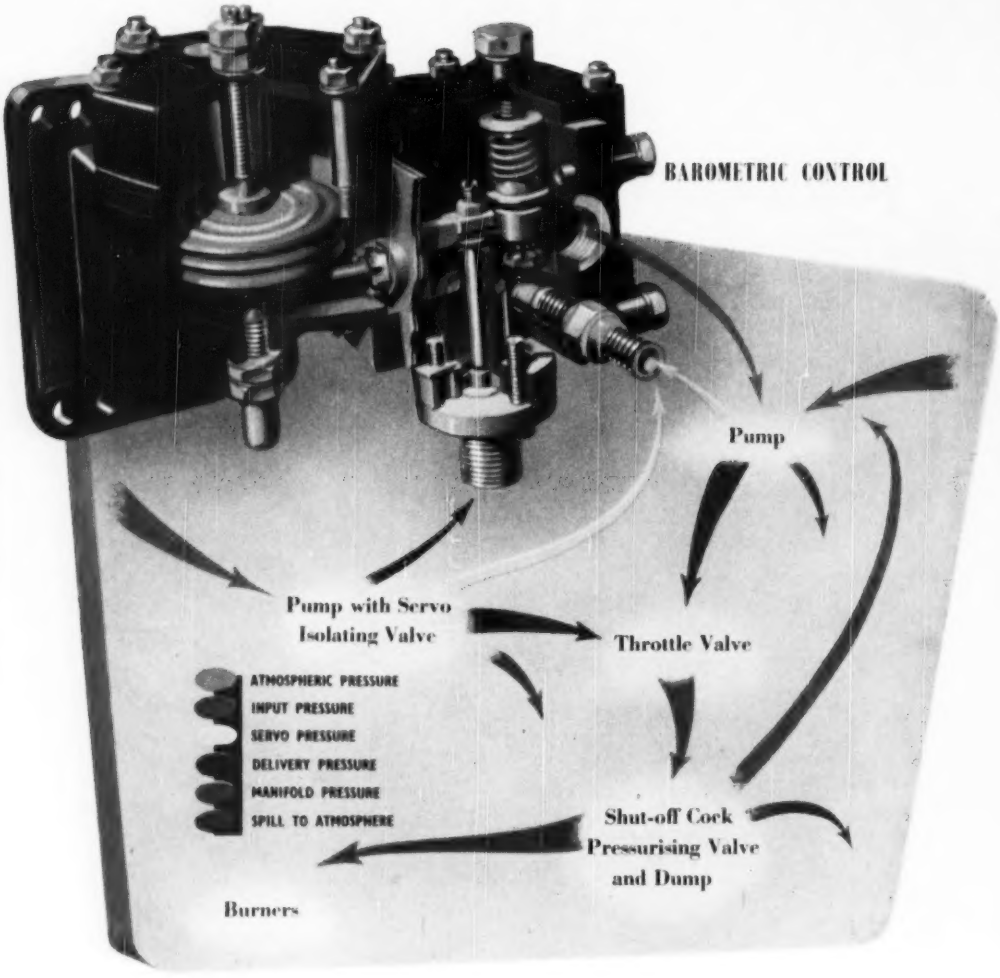

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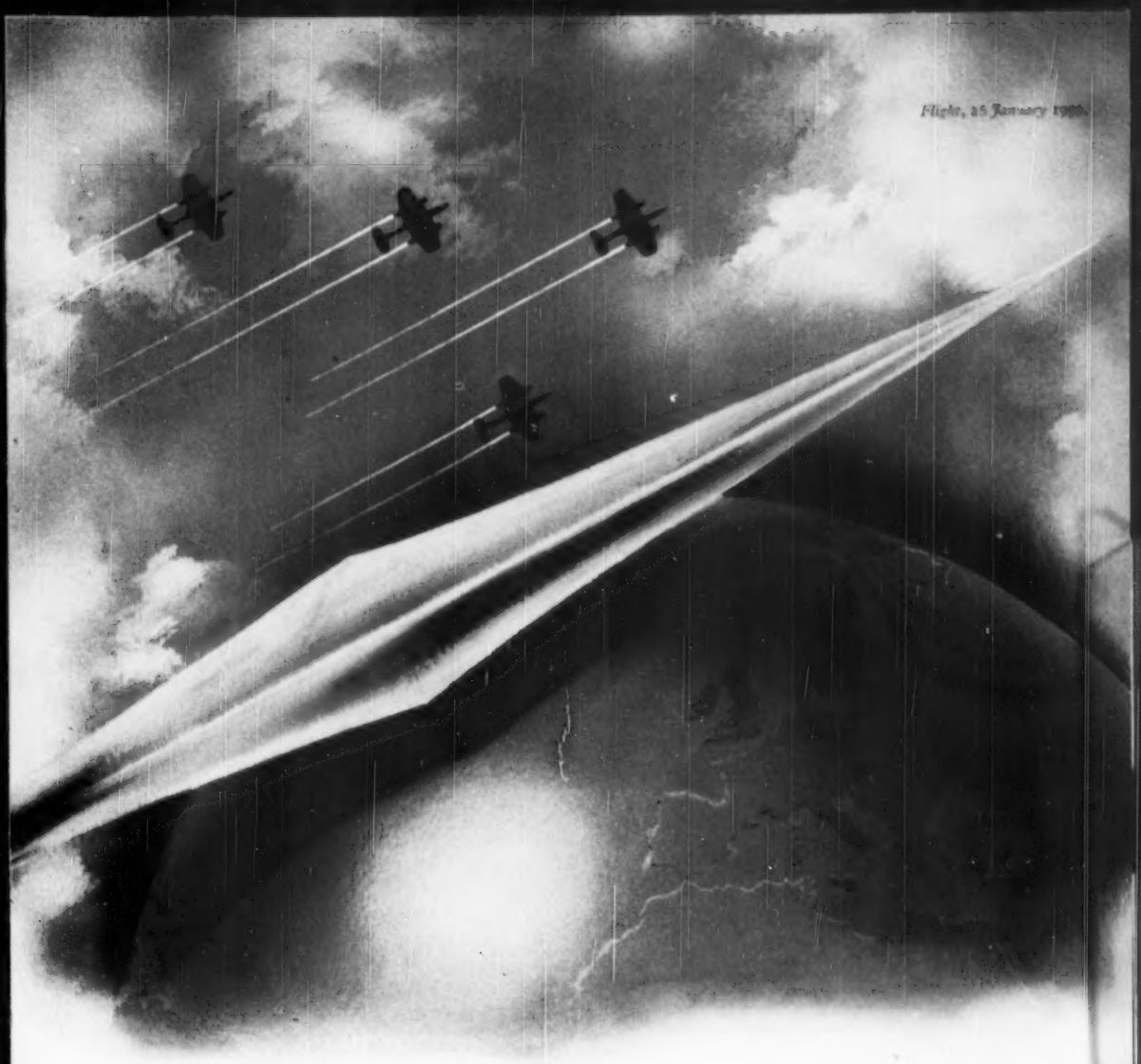

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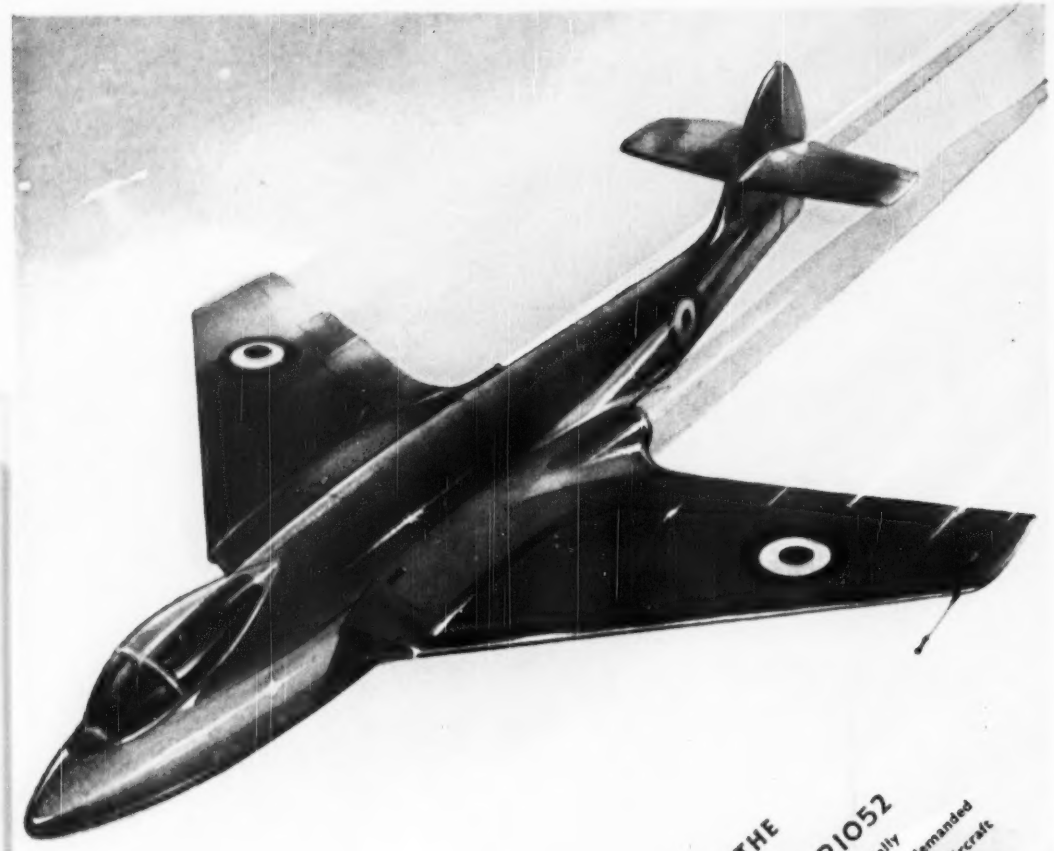

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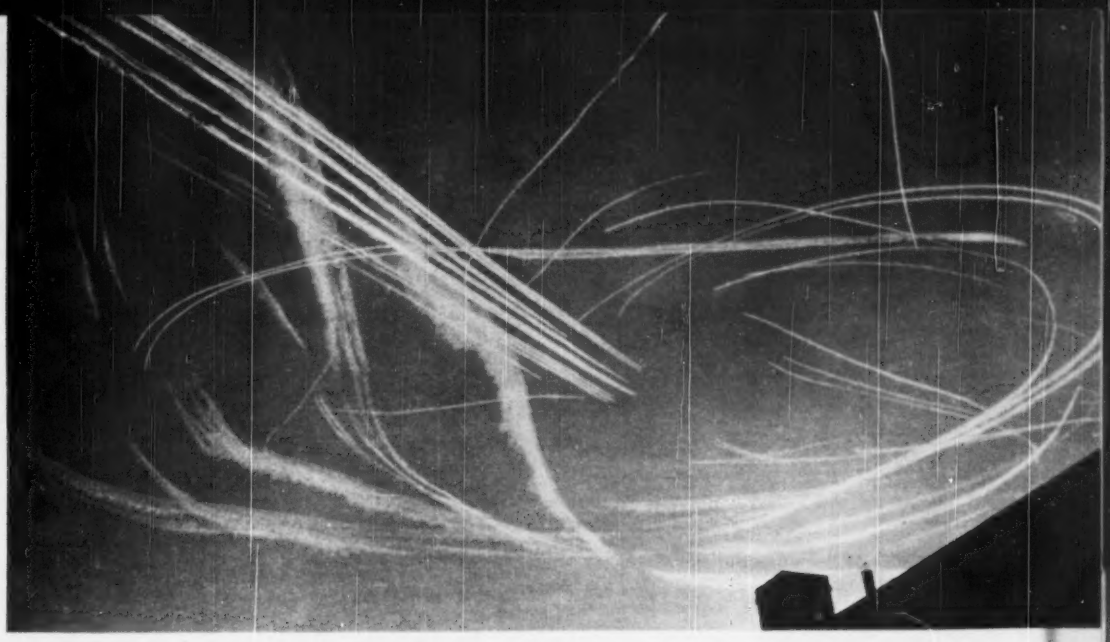


MILITARY *aircraft*

By H. F. KING, M.B.E.

TEN YEARS AGO the writer undertook a survey of the world's military aircraft, and a glance at the issue of *Flight* containing that study (March 14th, 1940) immediately discloses the extent of progress in the decade between.

In the distant days of early '40 the Hurricane, Spitfire and contemporary American fighters were being sedulously compared with the Me 109, and the Ju 87 dive bomber had just confirmed in Poland the tactical effectiveness it had earlier promised in Spain. Powered turrets, though lacking in Heinkels, Dorniers and Fortresses alike, were—to Britain's credit—standard equipment on Wellingtons and Whitleys, but R.A.F. fighters were armed with nothing heavier than rifle-bore machine guns. A large proportion of carrier-borne aircraft were biplanes. In those days the word radar did not exist, and the Lancaster and the Halifax were as yet secret. The rocket projectile was almost unknown in the air armouries, and a standard R.A.F. medium bomber was far inferior in striking power to a modern single-seat jet fighter.

The astonishing transformation now observed was brought about by the accelerating effect of the war and the advent of jet propulsion, and it is hardly an exaggeration to say that the picture just recalled differed from that of to-day as Trafalgar contrasted with Jutland. Standard fighters are regularly flying at 600-650 m.p.h. Prototypes have achieved supersonic speed and a height of 40,000ft has been reached in slightly more than four minutes, without recourse to the modern aids of afterburning or rocket boost. The radar-equipped all-weather jet fighter, for the perfection of which the Germans were striving at the war's end, is now seen to be coming into its own and is likely to predominate numerically in the years ahead in the British and American fighter arms. In the matter of range the newest jet fighters, especially those for naval use, are little inferior to the best of their piston-engined predecessors. Carrier-borne fighters of the immediate future will concede little to their shore-based counterparts on any score and may be the first to benefit from the elimination of the undercarriage and the adoption of flexible landing areas. Armament development, as ever, lags behind, the lack of improved guns and air-to-air rocket projectiles for special purposes being especially disturbing.

Existing jet bombers combine 550-650 m.p.h. speed with moderate bomb capacity and steadily improving radii of action; but for very-long-range operation the piston engine still prevails. A certain confusion, arising from swift and radical technical development in recent years, is evident in the training field; nevertheless, pure-jet trainers are firmly established in service.

The greatest interest attaches to new aircraft for anti-submarine work, especially to those with turboprop power. Military transports now match the speed of 1940 fighters and accommodate some of the bulkiest stores. New types of "assault" transports are commanding attention, and specialized military helicopters are under development.

To allow examination of these and other classes of Service aircraft, every effort has been made to amass the most complete and most recent information and to arrange it in assimilable form. In such assessments as he ventures, the writer has aimed at strict impartiality, seeking neither to gild nor blacken. Much to his regret he is restrained from including data for the newest British fighters and bombers, and frequently it has been necessary to instance American practice or achievement where British examples would have been preferred.

It has been considered expedient to deal with carrier-borne aircraft (other than specialized strike and anti-submarine machines) under the same head as their shore-based equivalents, but requirements peculiar to naval operation are duly considered.

Though guided missiles, other than those for air-to-air use, have no place in the present review, it is recognized that these must ultimately bring about the total disestablishment of piloted fighting aircraft.

Fighters

A Survey of Present-day Practice in Design, Armament and Equipment, and some Prospects for the Immediate Future

THE primary function of a fighter being destruction of the enemy in the air, it is with this commitment in mind that design practice will be studied under the present head, though the ready adaptability of current types for the secondary duties of ground-attack and reconnaissance will later be exemplified.

That, where known, the characteristics of opposing aircraft, and the circumstances under which these will be engaged, must be governing factors in the design of a fighter, is axiomatic. The unpleasant surprises sprung by the Fw 190 and "Zero" fighters and the very-high-altitude Ju 86P bombers during the late war are sufficient illustration of the dangers of deficient, or ineffectually exploited intelligence, and the present preponderance of "all-round" fighters over specialized, single-purpose designs is due in part to the inadequacy of information on the air equipment of a potential foe. Peace-time considerations of finance and man-power can likewise influence design practice, though in the main (and certainly this is true of Great Britain) the fighter arm is the last to suffer under the economy axe. It is well to remember, moreover, that the potency of an air force may stem largely from its operational flexibility.

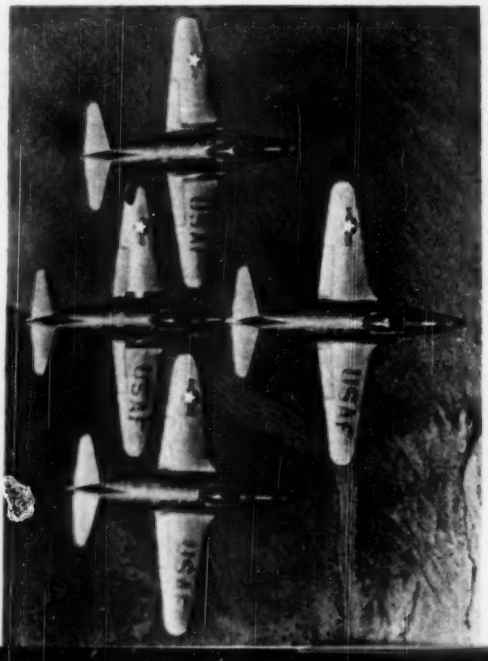
The bulk of fighter aircraft in service to-day are single-seaters, manifesting varying degrees of compromise between the cardinal requirements of speed, climb, ceiling, manœuvrability, acceleration, fire power and endurance, and designed initially for operation by day. They are typified by the piston-engined Fury, Spitfire, Mustang and La-11, and the jet-propelled Vampire, Meteor, Shooting Star, Thunderjet, Sabre, Mig-9 and Yak-15. For defence against aircraft operating by night, or taking advantage of bad weather in the target area, heavier two-seater piston-engined machines of lower performance (Mosquito, Twin-Mustang, Black Widow) are commonly employed, but their interim replacement by two-seat adaptations of single-seaters (D.H.113 and Lockheed F-94) is imminent.

Jet-propelled, radar-equipped, two-seaters, designed specifically for night and all-weather fighting, are already in production. The menace of the atomic bomber, exploiting new navigational and blind-bombing techniques, now necessitates the merging of qualities inherent in these two-seaters with those of lighter single-seaters, in order to secure a fighter capable of intercepting and destroying a high-flying jet bomber in the worst flying weather and at any hour. A paragon of the type envisaged has yet to appear; meantime, single-seaters in general are inadequately equipped for round-the-clock operation, while two-seaters—especially those which are sufficiently provided with radar and other aids—are somewhat inferior in performance. Experimental all-weather, radar-equipped single-seaters are under construction, and should these be satisfactorily developed, they will obviously be preferred to the massive two-seaters of 25,000-35,000 lb gross weight.

The demand for a specialized single-seater built, like the Republic XF-91, as an insurance against the fastest and highest-flying enemy aircraft operating by day, seems likely to persist; Russia, indeed, in her "target-defence" Me 263 development, has an intercepter even more restricted in application than the Republic. The requirement for a long-range fighter might be met by a variant of the "paragon" already mentioned, and with appropriate equipment this design should further be suitable for the short/medium-range bomber-escort, ground-attack, and, possibly, intruder roles. It must be recognized, however, that, having regard to the present high specific fuel consumption of the turbojet at ground level, a specialized intruder might be more advantageously powered by turboprop units, or even with piston engines.

Real danger of confusion lies in the somewhat academic attempts which have been made to classify existing fighters. Their own manufacturers not infrequently apply misleading terminology and a type described as a "strike" fighter to-day may be dubbed "long-range intercepter" to-morrow. But although, as already observed, the general run of present-day fighters are not, in the strict sense of the term,

Above: Metsors at exercise. Below: Air drill by Shooting Stars.



JET FIGHTERS AND FIGHTER-BOMBERS

Country of Origin and Designation	Span	Gross Weight	Power Unit(s)	Total Static Thrust (kilograms)	Max. Speed	Climb To	Climb In	Service Ceiling	Armament Guns	Armament Bombs (alternative loads)	Armament R.P.s	Remarks	Status
	ft	in	lb	lb	m.p.h.	ft	min	ft	mm	lb	lb		
GREAT BRITAIN													
de Havilland Vampire 6	38	0	12,350	de Havilland Goblin 3	3,300	540	40,000	14.5	48,500	4 x 20	2 x 1,000	8 x 60	Export version of Vampire 5.	I.S.
*de Havilland Sea Vampire 20	38	0	12,660	de Havilland Goblin 2	3,000	526	40,000	17	42,000	4 x 20			Has been tested (w/c raised) on flexible deck.	I.S.
de Havilland 113 Night Fighter (2-seater)	38	0	N.A.	de Havilland Goblin 4	3,350	well over 500	N.A.		N.A.	4 x 20			Staggered seats. Radar	P.
de Havilland Venom 1	41	9	N.A.	de Havilland Ghost	5,000	N.A.	N.A.		N.A.	4 x 20	Provision for bombs and R.P.s		Tip tanks do not prejudice projectile load.	P.
Gloster Meteor 4	37	1	15,175	2 Rolls-Royce Derwent	7,000	585	30,000	6.4	44,500	4 x 20	2 x 1,000	8 x 90	Avon - Meteor reaches 40,000ft in just over 4 min.	I.S.
Gloster Meteor 8	37	2	N.A.	2 Rolls-Royce Derwent	7,000	N.A.	N.A.		N.A.	4 x 20	Provision for bombs and R.P.s		Meteor 4 development; longer fuselage, new tail.	I.P.
*Hawker N.7/46	36	6	N.A.	Rolls-Royce Nene 4	5,000	600 approx.	N.A.		N.A.	N.A.			Width folded, 13ft 4in	P.
Hawker P.1052	36	6	N.A.	Rolls-Royce Nene	5,000	over 650	N.A.		N.A.	N.A.			Wing area, 256 sq ft	P.
Saunders-Roe S.R./A1 (flying boat)	46	0	16,255	2 Metropolitan-Vickers Beryl	7,700	over 500	I.R.C. over 4,000ft/min		N.A.	4 x 20	2 x 1,000	8 x 60	World's fastest flying boat.	P.
*Vickers-Supermarine Attacker 1	36	11	14,055	Rolls-Royce Nene 3	5,000	585	30,000	7.1	45,000	4 x 20	2 x 1,000	4 x 300	Naval and land variants. Suitable for afterburning	I.P.
Vickers - Supermarine 510	38	8	N.A.	Rolls-Royce Nene	5,000	over 650	N.A.		N.A.	N.A.			Expt. swept-wing development of Attacker.	P.
U.S.A.														
*Chance Vought XF 6U-1 Pirate	32	10	9,200	Westinghouse J-34 (with afterburning)	1,000	over 500	N.A.		N.A.	4 x 0.5in			"Metalite" skin.	P.
*Chance Vought XF 7U-1 Cutlass			22,000	2 Westinghouse J-34 (with afterburning)	6,000	over 650	N.A.		N.A.	4 x 20			Swept-wing, tailless.	P.
Consolidated Vultee XF-92A	31	0	13,000	Allison J-33 (with afterburning)	4,600	see note	N.A.		N.A.	No armament fitted			Delta-wing, designed for high subsonic speeds.	E.
*Douglas F3D-1 Skyknight (2-seater)	50	0		2 Westinghouse J-34	6,000	over 500	N.A.		over 40,000	4 x 20	Provision for bombs and R.P.s		Range 1,400 miles approx. Side-by-side seats. Radar.	P.
*Grumman F9F-2 Panther	41	2	11,000	Pratt and Whitney J-42 (Nene) (liquid injection)	5,000	600 approx.	N.A.		N.A.	4 x 0.6in	Provision for bombs and R.P.s		Camber of leading edge variable and inter-connected with flaps.	I.S.
Lockheed F-80C	38	10	15,336	Allison J-33 (liquid injection)	4,600	581	25,000	7	44,100	6 x 0.5in	2 x 1,000	8 x 5in	"Combat endurance" 3.2 hr.	I.S.
Lockheed XF-90	40	0	26,000	2 Westinghouse J-34 (with afterburning)	6,000	over 650	N.A.		N.A.	4 x 20	Provision for bombs and R.P.s		Supersonic speed reported but unconfirmed	P.
Lockheed F-94 (2-seater)	38	10	N.A.	Allison J-33 (with afterburning)	4,600	N.A.	N.A.		N.A.	4 x 20			Tandem seats. Hughes light-weight radar.	I.P.
McDonnell XF-85 (air-launched)	21	0	5,200	Westinghouse J-34	3,000	600 approx.	N.A.		N.A.	4 x 0.5in			Designed for launching from, and retrieving by, B-36 bomber.	E.
McDonnell XF-88	39	8	15,000	2 Westinghouse J-34 (with afterburning)	6,000	over 650	N.A.		N.A.	6 x 20	Provision for bombs and R.P.s		"Penetration" fighter, competitive with Lockheed XF-90.	P.
*McDonnell F2H-1 Banshee	41	7	14,000	2 Westinghouse J-34	6,000	630	I.R.C. 9,000ft/min		48,000	4 x 20 or 4 x 0.6in.	Provision for bombs and R.P.s		Has climbed to 52,000ft.	I.S.
North American F-86A Sabre	37	1	13,715	General Electric J-47A (liquid injection)	5,000	over 670	40,000	10-11	over 40,000	6 x 0.5in	16 x 5in		"Tactical radius" over 500 miles. F-86D is specialized interceptor.	I.S.
*North American FJ-1 Fury	38	1	12,700	General Electric J-35A	4,000	555	I.R.C. 5,100ft/min		44,000	6 x 0.5in			Max. range over 1,500 miles.	I.S.
Northrop F-89 Scorpion (two-seater)	55	0	over 30,000	General Electric J-35	8,000	over 550	N.A.		N.A.	4 x 20			Tandem seats. Radar.	I.P.
Republic F-84E Thunderjet	37	5	12,900	Allison J-35A	4,000	600 approx.	N.A.		over 40,000	6 x 0.5in	2 x 1,000	32 x 5in (possible)	Range 1,109 miles approx. Development, with flush intakes, may have radar.	I.S.
Republic XF-91	30	0	over 15,000	General Electric J-47 (and liquid rocket)	5,000	over 650	N.A.		N.A.	2 x 20	Nil	Nil	Inverse-tapered variable-incidence wing.	P.
FRANCE														
Marcel Dassault M.D.-450 Ouragan	37	2	12,300	Hispano-Suiza Nene	5,000	595	26,250	5	N.A.	4 x 20			Range with all tanks, over 1,100 miles.	I.P.
Sud-Ouest S.O.6020 Espadon	34	9	17,637	Hispano-Suiza Nene	5,000	over 600	33,000	10	N.A.	6 x 20			Max. duration 1.5 hr.	P.
SWEDEN														
Saab J-29	N.A.		N.A.	de Havilland Ghost	5,000	650 approx.	N.A.		N.A.	4 x 20			Undercarriage retracts into fuselage.	I.P.

Contractions: I.R.C.—Initial rate of climb; I.S.—In service; I.P.—In production; P—Prototype; E—Experimental (production not foreseen); N.A.—Information not available; *—Naval deck-landing aircraft.

of specialized design, many of them display some pre-eminent quality which prescribes their primary tactical role. Thus, the fast-climbing Meteor is first and foremost an interceptor; the docile, lightly-loaded Vampire a high-altitude fighter (though equally effective in ground level attacks); and the exceptionally fast, but heavily loaded, Sabre is particularly suitable, in its present form, as a "chaser" or "pursuit" machine. Naval deck-landing fighters, of which the Hawker Sea Hawk, Grumman Panther and McDonnell Banshee are typical, are generally "all-rounders", though endurance is accentuated in their technical make-up. As a class they differ relatively little from land-based fighters, but they are subject to special requirements, and due attention will be paid to them.

Irrespective of its particular application—whether its adversaries be piston-engined heavy bombers, high-altitude ultra-fast jet bombers, short-range or long-range jet fighters—a fighter must possess a high maximum speed, in order to overhaul the enemy or otherwise to position itself advantageously for the attack. Superior speed enables the fighter pilot to choose the moment of joining combat and of disengaging himself at will, and a high limiting Mach number, in which freedom from compressibility is implicit, is conducive to accurate shooting and to the pilot's peace of mind. Over-target heights of 35-45,000ft already being attainable by jet bombers, it follows that defensive fighters

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must possess the greatest possible speed *at altitude*, and to this necessity much of the current activity in developing thrust-augmenting systems can be attributed; but for defence against fast, low-flying raiders and flying bombs, sea-level performance remains vitally necessary.

Factors governing the speed of a jet fighter are aerodynamic cleanness, thrust, and wing loading. The compactness of the turbojet and elimination of the engine-cooling system have allowed the attainment of fuselage lines well-nigh to perfection, while the thrust offered by units of this type (now upwards of 6,000 lb static, without augmentation), in conjunction with an airframe of high aerodynamic efficiency, has already enabled a standard operational fighter, carrying full war load, to establish a world's speed record of 670 m.p.h. at low level. Using thrust augmentation, in one instance by liquid injection and in the other by tailpipe afterburning ("reheat"), at least two types of fighter are reported to have achieved supersonic speed. It is important to appreciate, however, that the aircraft concerned in these unconfirmed performances—the North American Sabre and Lockheed F-90—may, in common with other American jet fighters, have wing loadings so high as to exert a marked effect on handling qualities at altitude, and, while information on the performance of the newest American types is sparse, it seems not unjust to surmise that a striving for sheer speed may have had a prejudicial effect on other important aspects of their fighting effectiveness.

Though the relative degree to which requirements are stressed will obviously depend on intended Service applications, it may be presumed that climbing power is second in importance only to speed. Primary factors influencing rate of climb are thrust loading and wing loading, and it is not, therefore, surprising that British fighters, with advantages in both respects, should have displayed exceptional climbing powers. With two Rolls-Royce Avons, for instance, an experimental Gloster Meteor has attained 40,000ft in little more than four minutes, whereas for the standard Derwent-Meteor the corresponding time is slightly less than twelve minutes. A sustained climb to 56,500ft in 23 min 50 sec has been accomplished by a Ghost-Vampire of standard span; 50,000ft was reached in 13 min 30 sec.

The table preceding this page provides some indication of the climbing powers of certain other types, together with

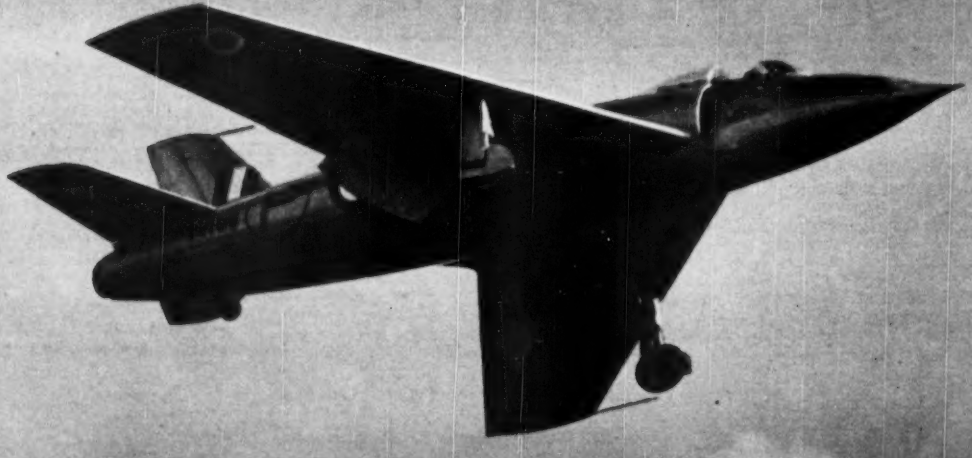
Vickers-Supermarine Attacker, powered by a Rolls-Royce Nene turbojet of 5,000lb static thrust. Maximum endurance is 3.65 hours.

service ceiling and endurance. As for the diving capabilities of modern fighters, at least one, having back-swept wing and tail surfaces, is reported to have achieved Mach 1.05 in a 35-deg dive and to have been prevented from attaining an ultimate figure of 1.275 only by structural restrictions, to be eliminated in a developed version. Indicative of the accelerations capable of being sustained by a present-day fighter in the hands of a first-class pilot wearing a G-suit was the performance of Sabres in last year's Thompson Trophy Race, when a 6-7g turn is said to have been held constantly, with turbulent air occasionally raising the load to 8-9g. Local structural failures resulted.

Other than the types named below, jet fighters in service or undergoing active development are low- or mid-wing monoplanes with a more-or-less conventional fuselage, or of nacelle-and-boom layout, with straight or swept-back wing and tail surfaces, and powered with one or two turbojets. The exceptions are the Saunders-Roe S.R./A1 flying-boat, with its high wing; the delta-wing Convair XF-92A (though bearing a fighter designation this is more strictly a research aircraft); and the tailless Chance Vought Cutlass.

A fighter's configuration varies according to the type, number and disposition of power units, the bulk and weight of armament, tankage, equipment and crew installa-

Vickers-Supermarine 510 (Nene), an experimental Attacker development.

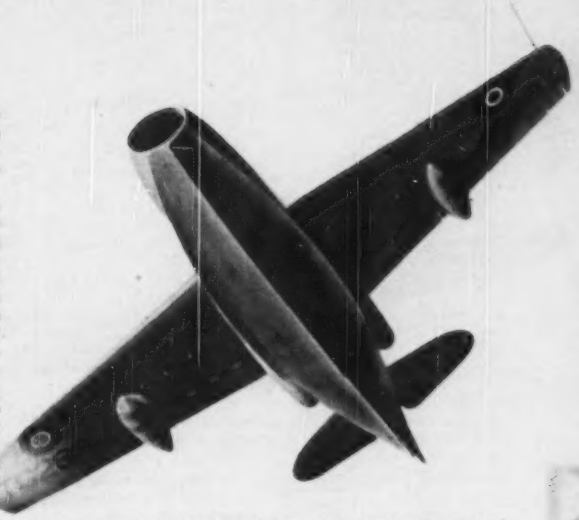


tions, and the degree of manœuvrability required at height. Design practice in relation to military requirements can best be studied, therefore, with respect to the major structural components, services and equipment. It is appropriate to begin with the wings.

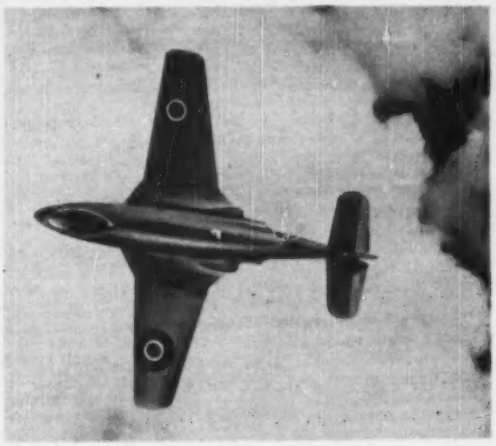
With the exception of naval designs, the newer types of fighter have thin, swept-back wings of moderate or low aspect ratio. Though minimizing the drag rise initiated at the critical Mach number, these unfortunately superimpose special problems, stemming from considerations of structure, stability and control. At high speed, control and stability of a swept wing are not abnormal, but there is serious deterioration in both respects at the lower end of the speed range, and tip stalling and spinning characteristics may be seriously affected. Slat-and-flap combinations can supply a certain increase in maximum lift. On the tailless Chance Vought Cutlass, leading-edge slats are fitted alone and a "droop-snoot," camber-changing leading edge is showing good results on the Grumman Panther. The new McDonnell types have chordwise "fences," located well outboard on the wings, to prevent spanwise drift of the boundary layer—an effective, if not, perhaps, wholly satisfactory, expedient, pending the perfection of means for controlling boundary layer behaviour in the region of the tips. The so-called "crescent" wing, with less rake on the outer than on the inner portions (the outer portions, moreover, being of thinner section) may mitigate the tip-stalling danger.

Unfortunately, the deficiencies of the swept wing are not wholly aerodynamic, for structurally a wing of this sort is necessarily heavier than a corresponding straight wing. These inherent defects notwithstanding, fighters and high-speed research aircraft with raked wing and tail surfaces are performing well, and the first non-German "swept" fighter—the Sabre, already named—is now in service. With the exception of the Republic XF-91, which has reverse taper, wings are tapered in the normal sense. This last-named type, it may be noted, is further abnormal in having a variable-incidence wing which, in view of its thickness/chord ratio, doubtless posed formidable structural problems, though less severe, perhaps, than those associated with the variable-sweepback arrangement now being studied in America.

The wing of a fighter must be designed with special regard to flexural stiffness and smoothness of surface. Conventional aluminium-alloy construction is generally employed, but some interesting departures from conventional practice are now observed. In particular, increasing use is being made of magnesium alloys, and the Chance Vought Cutlass is reported to utilize these materials to a



Above : A unique British jet fighter—the Saunders-Roe S.R./A1 single-seater (two Metropolitan-Vickers Beryl axial-flow turbojets). Below : Hawker Sea Hawk naval fighter with Rolls-Royce Nene.



Hawker P.1052 (Nene), a near-relation of the Sea Hawk.

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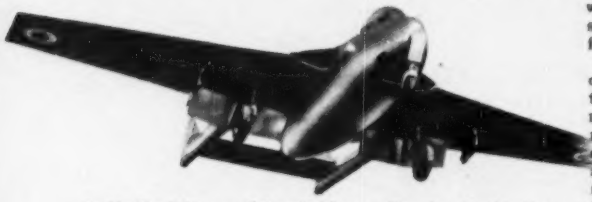


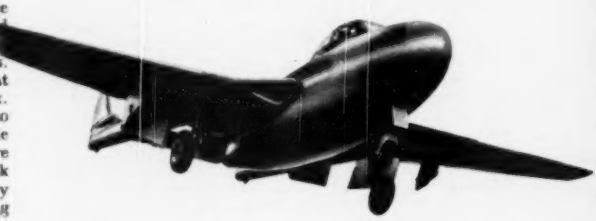
de Havilland Venom fighter-bomber, a Vampire development, powered by a D.H. Ghost turbojet of 5,000lb static thrust.

greater degree than any other fighter. An experimental wing for the Lockheed Shooting Star has been built in magnesium alloy, with resultant simplicity and—by virtue of the thick skin—favourable aerodynamic qualities. No substantial weight-saving is claimed in this instance. The Sabre has a very thin wing, swept back at 35 deg and utilizing sandwich-type construction, with the structural material laminated between inner and outer tapered skins. There are no ribs in the inner sections of the wing, at the root of which the skin is milled from sheet ½in thick.

Up to the present, designers have shown reluctance to use more than 35 degrees of sweep, but a 60-deg angle may eventually become common. There is a large measure of agreement that the ultimate development of sweep-back will be the delta, or triangular, plan form, having very sharply swept leading edges and a near-straight trailing edge. Especially suitable for supersonic flight, this configuration offers a favourable structural arrangement, a relatively small degree of stability change in the transonic régime and, if of lower aspect ratio than 2.5, elimination of tip stalling. Being deep in section, the classic Lippisch delta wing allows generous space for fuel and service load. Full-scale flight research with the Convair XF-92A delta is well advanced and new British designs of similar form are probably under development. A Martin-Baker project for a delta fighter has, in fact, been displayed as a model, but such information as has been released concerning the Avro 707 has not been linked with any fighter project. From America come reports of a Convair intercepter, designed in the light of experience with the XF-92A, and a twin-jet Douglas delta for the U.S. Navy.

But the fighter designer is generally required to reconcile very high speed, for the attainment of which sharp sweep-back or the delta wing form are indicated, with tractability at altitude. In the latter respect British fighters in general, and the de Havilland family in particular, are at present unsurpassed. It will be appreciated that as height increases and the stalling speed rises, the range of speed between the stall and the onset of compressibility is reduced, and ultimately eliminated; therefore it becomes necessary to delay this occurrence to the highest possible altitude. Pre-requisites for good handling qualities at height are low wing loading (to allow high-g turns and pull-outs), low span loading, and low thrust loading, which together make for a small turning radius and high attainable ceiling.

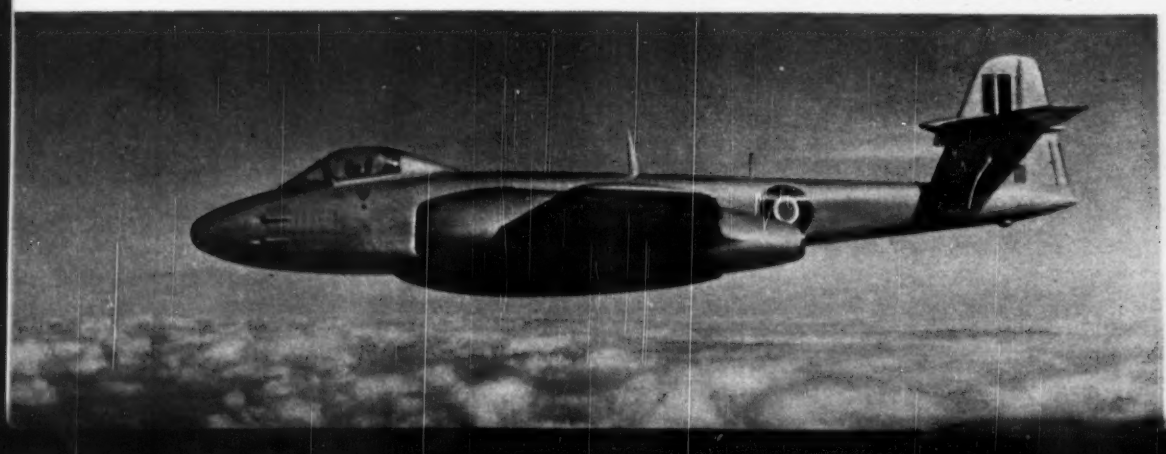
To enable the pilot to bring his guns to bear, precision of control is vital. In this connection it is claimed for the special long-span Ghost-Vampire which, on March 23rd, 1948, achieved a world's altitude record of 59,446ft, that no serious deterioration in handling qualities was noted even at the highest altitudes. Stability remained good and, though the aircraft was sensitive fore and aft, it was flown "hands off" at its ceiling. It was further reported that there was no tendency to rapid, unheralded straying into a stall or compressibility trouble as a result of changes in thrust or flight path. At 60,000ft pressure-altitude there was a speed range of 35 m.p.h. (120-155 m.p.h. indicated air speed), with a rapid improvement as altitude was de-

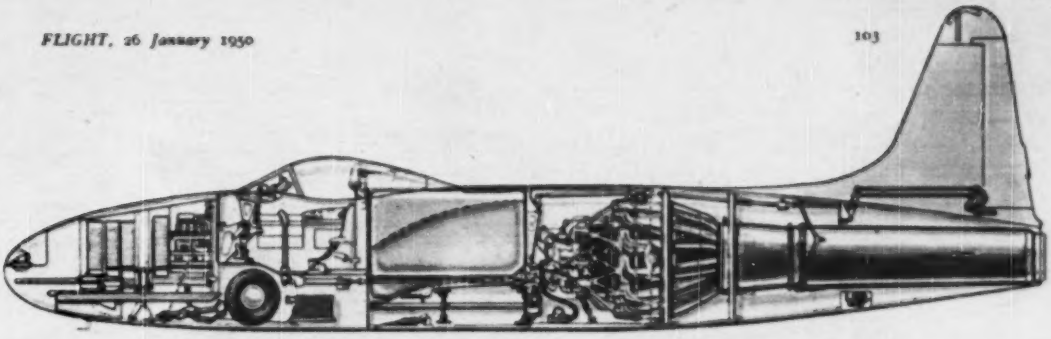


de Havilland Vampire Type 113 two-seater night-fighter, fitted with a D.H. Goblin 4 turbojet of 3,550lb static thrust.

Gloster Meteor 8, a development of the Meteor 4, powered by two Rolls-Royce Derwent turbojets.

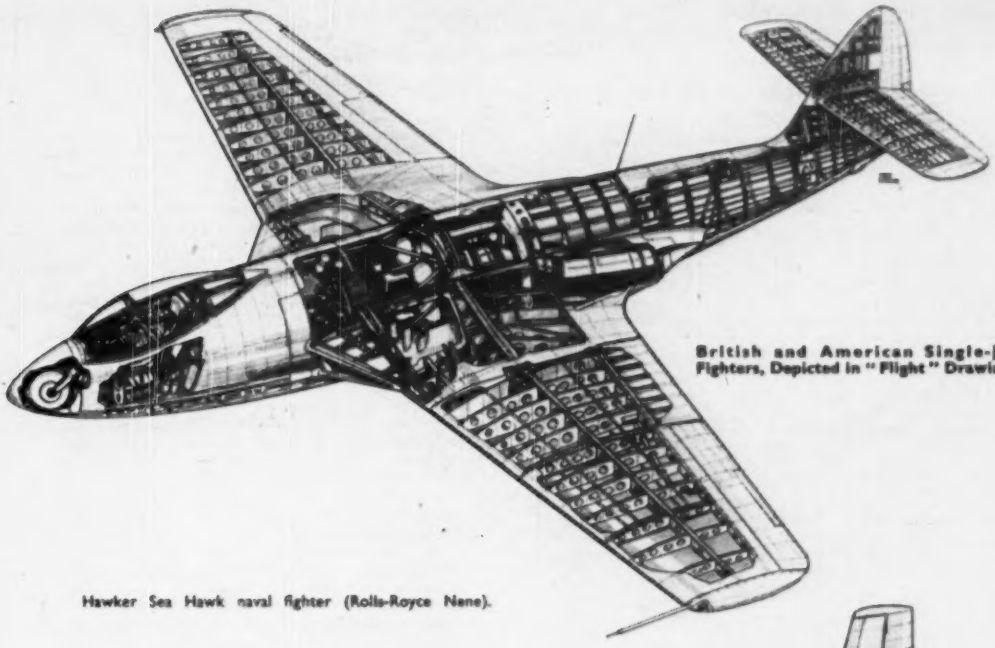
de Havilland Sea Vampire naval fighter (Goblin). Note flap area and arrester hook on this Naval development of the Vampire.



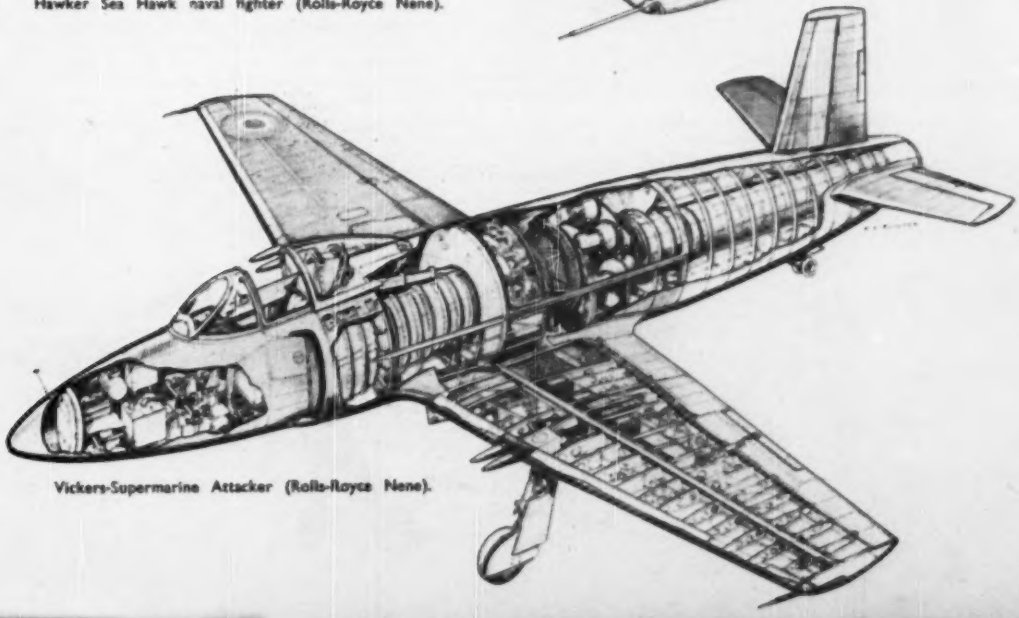


Lockheed F-80 Shooting Star with Allison J-33 turbojet.

British and American Single-Jet Fighters, Depicted in "Flight" Drawings



Hawker Sea Hawk naval fighter (Rolls-Royce Nene).



Vickers-Supermarine Attacker (Rolls-Royce Nene).

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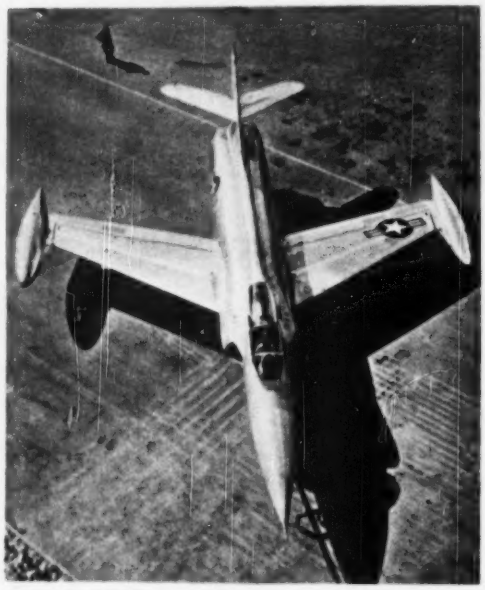
Above: An experimental tailless fighter—the U.S. Navy's Chance Vought Cutlass XF7U-1.



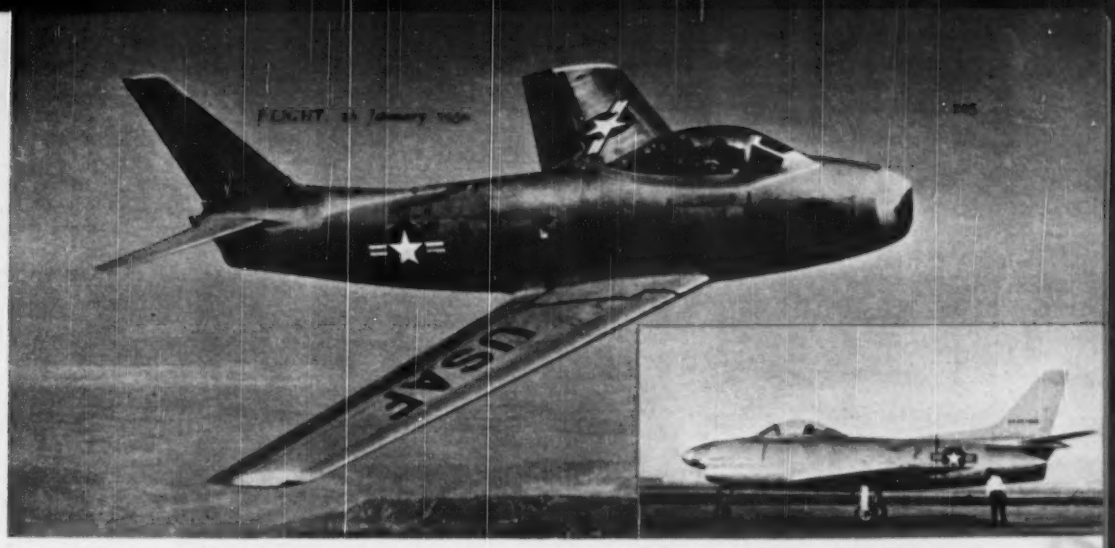
Lockheed XF-90 "penetration" fighter. Below: McDonnell XF-85 "parasite" fighter, designed to be launched from the B-36 bomber.

creased. Such exemplary behaviour, of course, is hardly to be expected of some later types of fighter which, though extremely fast at low and medium levels, are handicapped at altitude by high wing- and thrust-loadings.

It will now be apparent that designers find themselves at grips with fundamental difficulties: they are attempting to secure yet higher maximum speed without undue prejudice to the scarcely less vital requirements of rate of climb, ceiling, manœuvrability at height (by which a small turning radius is particularly implied), and those precise flying qualities which ensure that an accurate interception shall not be nullified by inability to administer the *coup de grâce*.

Before examining the fuselage as the major component next in importance to the wing, it is convenient to consider dive brakes, as adjuncts either to wing or fuselage. So effectively can these be used to aid manœuvring that they may be considered as control surfaces. They allow speed to be reduced very rapidly on closing with an enemy (particularly necessary at night and in bad weather), and permit a fast dive from operational height to sea level without exceeding the permissible Mach number. They are further valuable as a means of steepening the dive. Indicative of their effectiveness is the dive-brake performance of the Meteor 4, which can be put into a 70-deg dive at 32,000ft, with turbojets running at 97 per cent r.p.m., and a descent made to 4,000ft in about 1¼ min. The deceleration produced by closing the throttles and opening the brakes reduces speed to about 0.6 of that due to gravity at 400 m.p.h. "Decelerons," combining the functions of ailerons, dive brakes and landing flaps, have been applied to the Northrop Scorpion. Intercon-

Consolidated Vultee XF-92A, experimental precursor of a delta fighter for the U.S.A.F.



North American F-86A Sabre, with (inset) YF-86D derivative.

Below : Republic XF-91 turbojet-cum-rocket intercepter

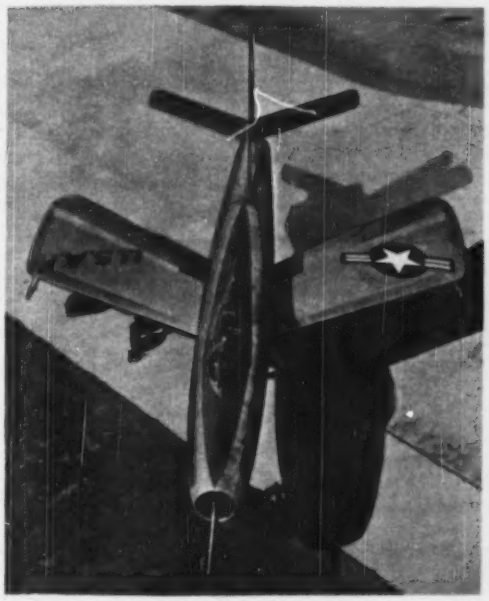
nection of the dive brakes with the Machmeter and A.S.I., whereby automatic extension of the brakes would prevent the attainment of undesirably high Mach values, is an obvious possibility.

It will be seen that, in consequence of the thin aerofoil sections now general, the fuselage must accommodate the armament, built-in tankage, and, in most instances, the power plant—either wholly or in part. Moreover, in many instances components of the undercarriage must also be disposed. Little wonder that new American "penetration" fighters have a 55-60ft fuselage! Among the better known and longer established fighter designs there are, of course, exceptions: thus, the Attacker has wing-mounted guns, and the Meteor's power units are located outboard. But in general it is true to say that the fuselage, or—with a twin-boom layout—the nacelle, contains the propelling and striking elements of the fighter, and that the wings and tail unit, except in so far as they may house the undercarriage, are principally of aerodynamic significance, though incidentally useful for the attachment of auxiliary fuel tanks.

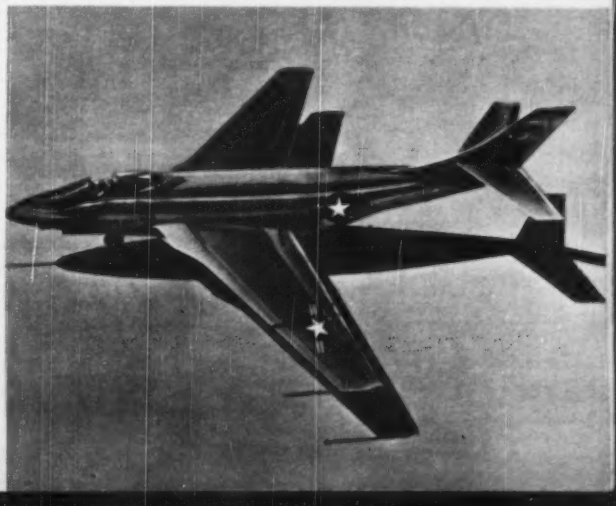
Changes in fuselage shape since the turbojet was standardized have included a tendency towards increased fineness ratios, which becomes particularly noticeable as axial-flow turbojets are more generally installed; refined nose lines (sharply pointed in the newest and fastest designs); and advancement of the cockpit towards the nose. Skins have been thickened, with structural and aerodynamic advantage, and some extraordinarily clean and beautiful shapes are in evidence. Power units mounted entirely apart from the fuselage are now uncommon, and in general it is correct to say that the internal economy of a jet fighter's fuselage is governed by the type and disposition of the power plant, the run of associated intake ducting and tail pipe(s), the extent of fuel tankage, the character and bulk of military equipment, and the nature of crew-provision. All these factors will be separately treated, but having now disposed of the wing and fuselage, it is, perhaps, fitting to consider the tail unit and controls, so completing our survey of the airframe proper.

Fighter configurations include what may be called the conventional, i.e., having vertical and horizontal tail surfaces mounted on the fuselage, or attached by booms to the wing/nacelle assembly; the semi-tailless, with no horizontal tail surfaces; the tailless; and the delta. Of types extant, only one—the Cutlass—diverges from the "conventional" formula, though two high-speed research aircraft (D.H.108 and Northrop X-4) are semi-tailless, and the Convair XF-92A and Avro 707 are of pure-delta form. While offering an important drag reduction, the semi-tailless and tailless layouts have the inherent disadvantage of short "elevon" or "ailevator" control leverage—a factor of importance in combat.

Though conventional balanced ailerons are giving place to power-assisted surfaces, spring-tab systems continue to



McDonnell XF-88 "penetration" fighter (two Westinghouse J-34).



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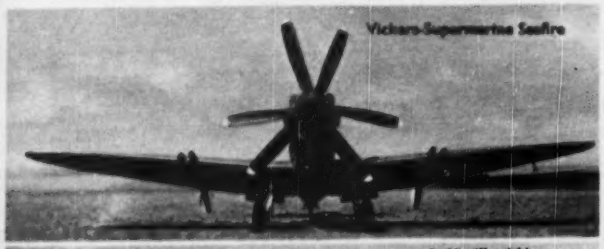
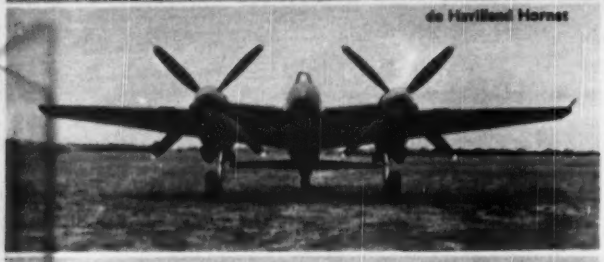
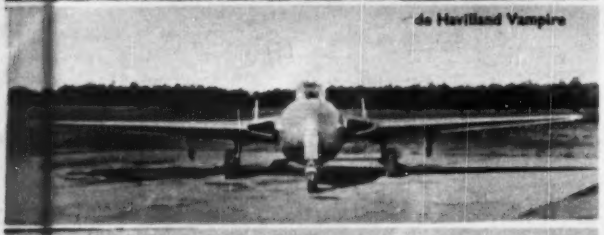


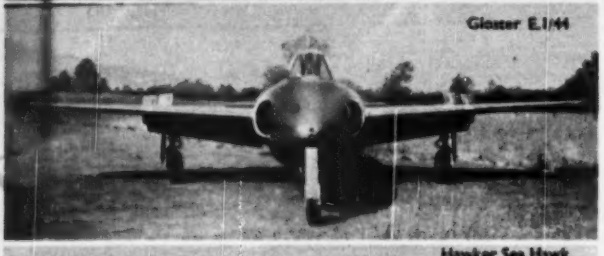
Vickers-Supermarine Seafire



de Havilland Hornet



de Havilland Vampire



Gloster E.1/44

Hawker Sea Hawk

Hawker P.1052

Northrop F-89 Scorpion

show excellent results on the Hawker jet fighters. It is known that the Shooting Star system, when using a power-boost ratio of 15 : 1 (i.e., with the mechanism multiplying the pilot's effort by 15), a rate of roll of 150 deg per second can be attained at intermediate heights, and much higher rates at 30,000ft. With boost ratios of up to 28 : 1 phenomenal rates of roll are possible, but these are considered neither necessary nor desirable. Among American types the Thunderjet was the first to have an automatically adjusted aileron booster system to vary the application of force with air speed.

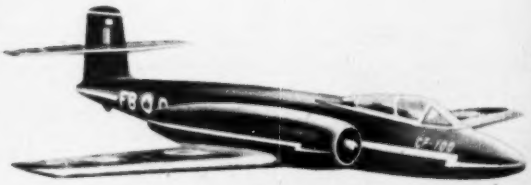
Sharp divergence from common practice in providing lateral control is evident in the French N.C.1080 naval fighter, which has no ailerons in the normal sense, but utilizes special Lemoigne-type compensators at the wing tips.

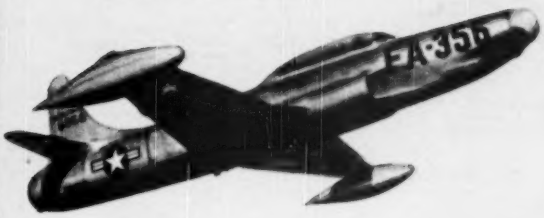
Considering, now, the power plant as applied to fighter aircraft, it must be notified at the outset that, though the piston-engined Hawker Fury and D.H. Hornet families, and, in America, the Grumman Bearcat, continue in production, the reciprocating engine has been honourably dismissed from this review, allowing attention to be concentrated on the turbojet (the universally accepted prime mover for fighters) and, to a lesser extent, the rocket. No account will be taken of the ram-jet, or athodyd, though it is recognized that this form of power plant may find an application in supersonic fighters.

It is significant that, whereas the engine designer requires for his turbojet the most direct intake—free from structural or other impediment to the incoming air—and a tailpipe of optimum length, the aircraft designer must balance these considerations against the need for marrying power plant and airframe with the minimum of aerodynamic interference, and without undue prejudice to tankage, armament, pilot's position or, in the case of new all-weather fighters, radar. Of these items tankage is of paramount importance, for not only is the specific consumption of the turbojet high, but this type of unit allows little economy by "throttling."

All jet fighters now in being have one or two turbojets, with or without a thrust-augmenting system in the form of liquid injection or tailpipe afterburning. In a few isolated instances one or two liquid rockets provide additional thrust for take-off, climb and combat at high altitudes. The only existing type to have rocket power alone is the Soviet development of the German Me 263.

Avro Canada CF-100





Lockheed F-94

Three distinct forms of turbojet are currently being installed: the classic Whittle type, with double-sided, centrifugal compressor, represented by the Rolls-Royce Derwent, Nene, and Tay; the centrifugal form, with single-sided compressor (de Havilland Ghost); and the axial-flow type (Rolls-Royce Avon, Armstrong Siddeley Sapphire, General Electric J-47, etc.). Though centrifugal-flow turbojets of 3,500-5,500 lb thrust (without power boost) remain numerically the most common—at least in Great Britain, the U.S.A. and on the Continent—the axial-flow unit is being increasingly adopted throughout the world, by reason of its slim form, high compression ratio and resulting lower specific consumption. Certain of the light, simple and very reliable centrifugal units already in service, however, seem amenable to extensive development, and models developing well over 6,000 lb thrust (comparable with the most powerful axials now in production) are certain to be announced within a few months.

With the possible exception of the Soviet Yak-15, which, in effect, has its axial-flow unit underslung from the forward body and ejecting beneath the rear fuselage, current single-jet fighters mount the jet unit wholly within the fuselage or nacelle. The wartime He 162 Volksjager, however, had a turbojet superimposed on the fuselage, and there were other German designs for fighters with a single jet unit underslung at one of several possible positions.

Being short in length, a centrifugal unit, like the Nene or Ghost, is suitable for inter-spar mounting, whereas a longer axial unit may have to be disposed above or below. With a "buried" fuselage installation the air may be taken in through a nose duct (Thunderjet); through wing-root intakes (D.H. and Hawker fighters); side intakes (Attacker and Shooting Star); underslung intakes (first prototype S.O. Espadon); or upper-fuselage intakes (Avro 707).

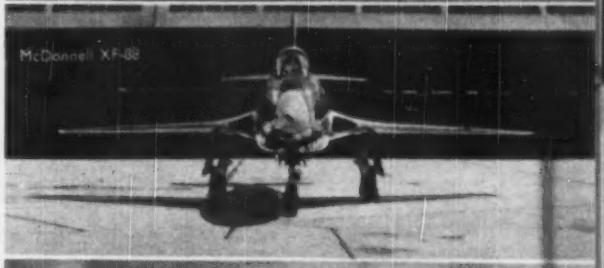
An obvious disadvantage of the nose intake is the impossibility of mounting equipment in the forward tip of the fuselage. A requirement for forward-mounted radar in the nose-entry Thunderjet, for instance, has led the Republic Company to collaborate with the N.A.C.A. in developing flush side-inlet ducts. The new ducts were considered to give the desired flow characteristics and pressure recoveries, provide ample room for equipment, and necessitate the minimum of change in structural and aerodynamic characteristics. Rate of climb is reported to be improved and in other respects performance equals that of

Douglas F3D-1 Skyknight

Vickers-Supermarine Attacker

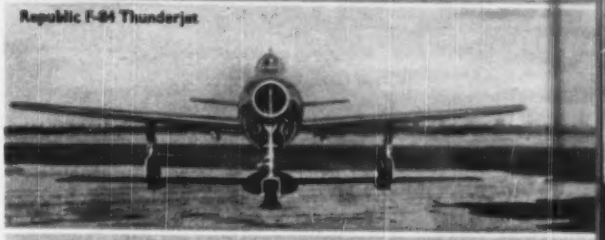
Vickers-Supermarine 510

McDonnell XF-88

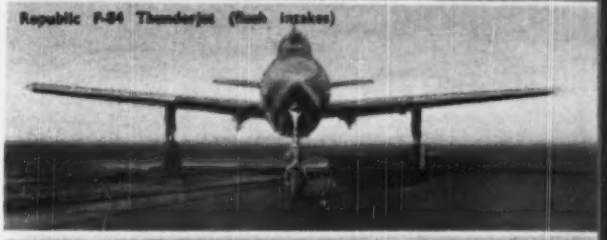


Hawk Aeronca F3-1 Fury

Republic F-84 Thunderjet



Republic F-84 Thunderjet (flush intakes)



Northrop F-89 Scorpion

Fighters . .

McDonnell F2H-1 Banshee naval fighter (two Westinghouse J-34)

the normal Thunderjet. However efficient an intake may be in respect of energy recovery and thrust increase, the designer must ensure that these advantages are not cancelled out by increased aerodynamic drag.

In most instances the jet exit is in the extreme rear of the fuselage or nacelle, but exceptions are to be seen in the new Hawker fighters, having a bifurcated jet pipe and twin exits partially countersunk into the fuselage behind the wing roots, and the Swedish SAAB-29, from which the jet stream is ejected through a short tailpipe forward of the empennage. Though, as affecting a simple turbojet, a long tailpipe is undesirable, it may prove an asset if an afterburner is to be incorporated, though this somewhat bulky fitment, in turn, may mar the original fuselage lines. This has, in fact, occurred in the "Reheat Vampire," Shooting Star night fighter (F-94) and Chance Vought Pirate. That a long tailpipe and spoiled fuselage lines are not inseparable from "reheat" is proved by the XF-88, with specially developed short afterburners and F-86D.

Republic's F-91 intercepter is the only fighter known to be flying with both turbojet and rocket power. The prototype has four solid-fuel rocket motors, disposed in fairings above and below the turbojet nozzle in the extreme tail, but a Curtiss-Wright XRLCW-1 liquid rocket is intended. Obviously it is desirable to enclose the bulk, if not the whole, of a rocket unit in the fuselage; so the latest Hawker airframes, with their sweeping lower-fuselage lines, appear especially suitable for the installation of an auxiliary rocket unit in the lower rear body.

For take-off the most heavily loaded American fighters are occasionally given rocket assistance. The Shooting Star, for instance, has provision for two JATO units, each of 1,000 lb thrust. No British land-based fighter requires such aid.

A twin-jet fighter affords a greater safety margin than a single-jet type, especially at night or in bad weather, and, if the jets are mounted near the centre-line, allows economical cruising on a single unit. In laying out a twin-jet fighter a designer has the choice of attaching the power units to the wing outboard of the fuselage; of burying them in the wing roots; countersinking them partially into the fuselage sides; placing them above and/or below the fuselage; or—in the case of an internal installation—disposing them side by side, superimposed or staggered. Classic examples of outboard wing installations are the Gloster Meteor and the Me262A. Both are of wartime design, but their basic layout, which is obviously beneficial to maintenance, is by no means obsolete and is, in fact, reproduced in the all-weather Curtiss F-87 and the English Electric Canberra, a light bomber with potentialities as a fighter. Wing-root mounting (which introduces the difficulty of transferring spar loads) is illustrated by the McDonnell naval fighters and Vought Cutlass, while the twin jet-units of the Avro Canada CF-100, Northrop Scorpion and Douglas Skyknight are built in to the sides of the fuselage. The hull of the S.R./A1 flying boat is distended to allow the twin Metrovick Beryls (mounted side by side, and fed by a bow intake) to discharge aft of the wing. Representative of an underslung installation is the Soviet Mig-9. The power plants of the following fighters are wholly internal: Lockheed XF-90 (side-by-side units, outlets at rear of fuselage); McDonnell XF-88 (side-by-side units, outlets in lower fuselage); French S.E.2410 fighter/attack aircraft (staggered units, outlets in tail).

On the score of accessibility, it will be observed that the Vampire, by virtue of its short nacelle, completely detachable cowlings, and the single-sided impeller of its turbojet, is advantageously placed, as is the Meteor, with its outboard nacelles. In the Sabre, Shooting Star and Thunderjet the rear fuselage is detachable as a unit, allowing access to the turbojet and permitting rapid replacement. The twin axial-flow units in the wing roots of McDonnell naval fighters can be withdrawn rearwards.

With intakes located some distance aft along the fuselage (which arrangement, by leaving the nose section free for the cockpit and service equipment, is gaining in popularity), it becomes necessary to dispose of the boundary layer at the intakes. This can be accomplished either by suction slots, as on the Supermarine and Hawker fighters; by providing shoulders, exemplified by the Venom and Avro CF-100; or by arranging the intake scoop(s) to stand proud of the fuselage (first Espadon prototype, now being redesigned). Where it is proposed to cruise on one of two turbojets, or to provide for failure, as on the McDonnell Phantom, the intakes are provided with controllable shutters, to permit closure of a duct to an inoperative unit.

Fuel tankage on a typical jet fighter is mainly in the fuselage, the wings in general being too thin, but auxiliary jettisonable tanks of substantial capacity can be carried beneath the fuselage (if ground clearance allows), at the wing tips, or—where sharp sweep or other considerations render tip-mounting impossible due to consideration of c.g. displacement—beneath the wing, as on the Sabre. The tip tanks in the Lockheed XF-90 hold 180 gallons each, and a 250-gallon ventral tank has been developed for the Supermarine Attacker. With a multiplicity of tanks it is necessary to provide an automatic transfer system to retain the c.g. within limits as fuel is consumed. Bag-type tanks are now commonly employed.

There is no indication that the "Deichselschlepp" towed-tank arrangement, as studied jointly by Messerschmitt and Arado late in the war, and intended for the Me 262 and Ar 234, has found any favour with British or American authorities, but the feasibility of refuelling jet fighters in the air was demonstrated by Flight Refuelling, Ltd., during August last year, when a Meteor 3, its tanks replenished ten times from a converted Avro Lancaster, remained airborne for twelve hours.

In all jet fighters, other than the Soviet Yak-15, the

De Havilland Sea Hornet fighters aboard H.M.S. *Implacable*.

North-American FJ-1 Fury naval fighter (General Electric J-35).

Grumman Panther naval fighter jettisoning fuel from tip tanks.

cockpit is located well forward, and generally allows an excellent field of view for take-off, landing, climbing and fighting. Whereas the later types of piston-engined fighters afforded a downward view of, say, 5 deg, over the nose, an angle of 17 deg is now attainable. The cockpit is, of course, pressurized, and may be automatically air-conditioned, and the seats on all the newest types can be ejected to enable the pilot to escape at speeds of over 500 m.p.h. There is a strong opinion in some quarters that in a two-seater night-and-all-weather fighter a side-by-side or staggered seating arrangement is greatly superior, from an operational standpoint, to a tandem lay-out, though it may be noted that in the Northrop Scorpion and Avro Canada CF-100 the pilot and radar operator have tandem seats.

In the latest form of Martin-Baker ejector seat the pilot's parachute, stowed in the seat chassis, is opened automatically, even though the pilot may be rendered unconscious after leaving the aircraft. So long as the face blind is pulled down, safe ejection is assured. On ejection, a time switch is triggered for a period of six to nine seconds, after which a drogue parachute is released from the seat and automatically pulls out the pilot's 28ft canopy, simultaneously releasing him from his seat harness. The time switch is barostatically controlled so that, although ejection may take place at any height, the switch will not operate until the seated pilot has fallen to 10,000ft, at which point separation occurs.

Emergency exit is normally made upwards but on the Douglas Skyknight, which has an abnormally tall fin, there is an escape chute extending from the cockpit to the fuselage underside. The first aircraft with a self-contained jettisonable fuselage section, embodying the cockpit (this so-called "capsule" feature may become common on fighters), is the Douglas Skyrocket high-speed research machine.

Whereas a conventionally seated pilot can withstand only about 5g without blacking out, the prone position may allow him to tolerate 12g, and accelerations of this order have already been recorded with a "live" test rig. Concomitant benefits are reduction of fuselage drag, elimination of the conventional cockpit canopy, and lessening of the fatigue danger. An American prone position "bed" is of nylon netting, arranged to conform to body contours and having an adjustable abdominal support. There is a padded jaw-rest, likewise adjustable, and a counter-weighted support to relieve neck-strain. After tests in the nose of a converted Fortress bomber, this type of position will be applied to a Lockheed Shooting Star.

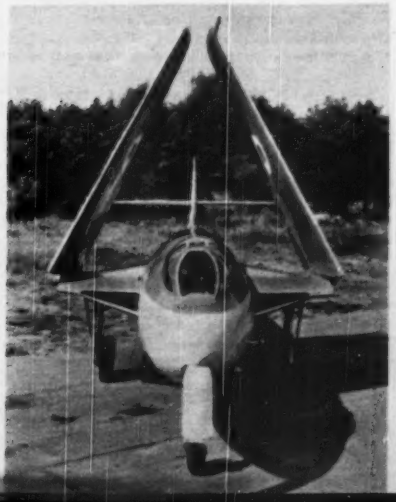
Although the armament and other military equipment has not yet been discussed, some idea may have been conveyed of the extent to which the power plant and crew provision may occupy fuselage space. In general it is difficult to house the retracted undercarriage in the fuselage, but the Swedish SAAB J-29 has a body of large cross-section, which serves not only to house the wheels but is used for the attachment of the undercarriage.

Tyre width and wheel diameter are major considerations for convenience of wing stowage, and American designers are turning increasingly to high-pressure tyres and multiple-wheel units, exemplified in the Republic XF-91, with its small tandem wheels retracting outwards into the wing tips. Duplication of wheels is, of course, a valuable safety feature. In certain instances high-pressure tyres are fitted for operation from normal airfields and runways, and low-pressure tyres, with special fairings, for rough-surface work.

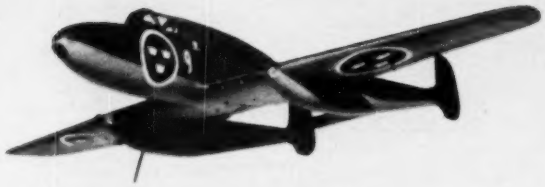
Only two types of jet fighter—the Supermarine Attacker and 510—have a tail-down undercarriage, and their makers express themselves well pleased with the weight-saving thereby effected.

The possibilities of jettisonable wheels, used in conjunction with a landing skid, were demonstrated by the wartime Me 163 rocket-powered intercepter, and a landing skid is also a feature of the McDonnell XF-85 air-launched "parasite" fighter, stowed semi-internally in the bomb bay of a B-29 or B-36 bomber. The pilot of the XF-85 having failed to engage with a trapeze lowered from the parent bomber, he was twice obliged, during early tests, to set the tiny fighter down on its skid at a speed in the neighbourhood of 170 m.p.h.

A single-jet Hawker Sea Hawk (left) is shown with folded wings for comparison with a twin-jet McDonnell Banshee.



Fighters . .



The Swedish Saab J-29 is powered by a de Havilland Ghost.

Top: Saab J-21R (Goblin); below: Marcel Dassault Ouragan (Nene).

The benefits promised by elimination of the wheel undercarriage, which becomes possible with the flexible flight decks already developed in Great Britain, are of greater moment than is, perhaps, generally appreciated. Weight, amounting to 5 per cent of the total, should be readily saved, allowing commensurate augmentation of performance, range or armament. Not only may the design of aircraft carriers be revolutionized, for long flight decks will be rendered unnecessary, but naval craft of several classes may serve as mother ships, thereby extending the defensive and offensive power of the Fleet. The ultimate influence of the flexible-deck-cum-wheelless-fighter technique, however, seems unlikely to remain a naval prerogative and may conceivably be adopted on a restricted scale for land-based intercepter operations, the fighters, as on a ship, being accelerated at take-off. The first "flexible deck" experiments in Great Britain were, indeed, conducted ashore—at the Royal Aircraft Establishment—utilizing specially reinforced Vampires. Provision has been made for retracting flaps and dive brakes at the instant of touch-down to avoid structural damage. Many successful landings have been effected on the flexible flight deck of H.M.S. *Warrior*.

For operation from water Saunders-Roe, Ltd., have developed their S.R./A1, to which reference has already been made, and in America Convair are said to be building a machine—the Skate—of somewhat similar type. Hull-drag notwithstanding, the "A1" attains over 500 m.p.h. and is highly manœuvrable, but now that speeds of 650 m.p.h. and higher promise to become general within a few years, the conventional flying boat will be placed at an increasing disadvantage.

Having now examined the fighter's airframe, its power plant, tankage, and means of taking off and landing, the moment has arrived to take stock of its armament, for the effective employment of which the aircraft is, after all, designed. Though ramming was practised by the Soviet and Japanese Air Forces and was considered by the Germans (and—in the specially armoured, but now abandoned, Northrop XP-79—by the Americans also), the weapons of the modern fighter are automatic guns, multiple rocket projectiles, large proximity-fused missiles and special homing or guided missiles (likewise having proximity fuses).

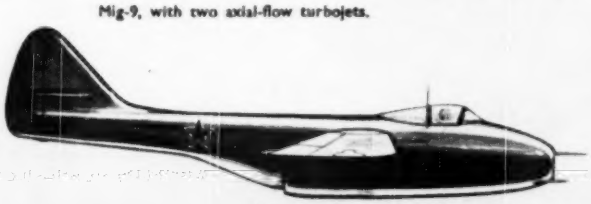
The standard armament of British fighters remains as four 20 mm Hispano guns for which the Meteor carries 770, the Vampire 600, and the Attacker 624 rounds. Some of the newer American fighters have similar armament, and at least one type mounts six 20 mm guns, but the 0.5in improved M-3 Browning-type gun, firing at about 1,200 r.p.m., still predominates in the U.S.A., supplemented by a few installations of 0.6in guns (muzzle velocity 3,300 ft/sec) on naval aircraft. For its six 0.5in guns the Shooting Star carries 1,800 rounds. The Soviet Air Force uses a 12.7 mm gun in addition to 20-23 mm, and larger-bore weapons, while the French and other Western Union nations standardize on 20 mm armament, in conformity with British practice. Except in the case of the Attacker, all British jet fighters have fuselage-mounted guns, but, though the Vampire 113 night fighter retains the fuselage installation, it might be necessary with other radar-equipped adaptations to transfer the guns from the nose to the wing.

The armament problem as affecting fighters is primarily one of inflicting the maximum damage in the shortest possible time. In countering the atomic-bomb carrier the fighter must be able to deliver a knock-down blow the instant it has closed with a raider, and the armament to accomplish this may exert an important effect on the design of the aircraft. Weapons (other than fixed guns as in service to-day) may be listed as follows: (1) Large-bore automatic guns of 30-75 mm calibre, exemplified by the German low-velocity MK 108 and high-velocity MG 213/30. (2) Small-calibre rocket projectiles (typified by the German 55 mm R4M), in multiple installations or with an automatic launcher. (At least 36 of these could be carried by a present-day fighter and would be especially valuable in head-on attacks for disrupting formations of heavily armed bombers.) (3) Large, proximity-fused missiles, possibly launched from a recoilless gun, in which gas momentum would balance that of the missile. (4) Guided missiles, of which the German X-4 was an elementary form. (5) Homing missile (e.g., Ryan Firebird).

Careful fairing or internal stowage for projectiles will, of course, be necessary if the Mach number of the fighter which carries them is not to be drastically reduced, and if (in the case of unguided projectiles) undue ballistic spread is to be avoided. The recoilless gun will bring its own problems, of which the rearward-discharged gases and feeding of the abnormally bulky ammunition are but two.

Soviet Me 263 development, with liquid-fuel rocket.

Mig-9, with two axial-flow turbojets.



Top: Sud-Ouest Espadon (Nene turbojet); below: Sud-Ouest Narwal (Arsenal 12H piston engine).

Soviet Yak-3 fighter fitted with a VK-107 engine.

Finally, it can be said that the resuscitation of movable, "aimable" guns now appears to be a possibility, though the installations—of axially restricted type—would bear little resemblance to those dating from pre-war years.

For crew protection it is common practice to provide steel and laminated dural armour and bullet-resisting windscreens. Titanium is being used experimentally.

Gunsights on new British fighters are retractable, to improve view for search. Concerning the later types of sight and airborne fighter radar, there is little information to draw upon, though reference has been made in the American press to the British A.I.Mk.9. "lock-follow" system in which a graticule, air speed, horizon and target are projected on the windscreen so that the pilot need not remove his eyes from the night sky. When contact is made, radar and automatic pilot are so interconnected that, in theory, the fighter and its quarry remain in contact until the autopilot is disconnected. A range of nearly 20 miles is reported for the radar in the Douglas Skyknight. Radar-controlled armament is already being installed in the McDonnell Banshee.

Of instruments, it may be remarked that those of gyroscopic attitude-indicating type have the defect that if attitude limits are exceeded they may "topple." Non-toppling electric artificial horizons are therefore being developed. Moreover, where instruments are dependent upon the aircraft electrical system, battle damage might leave the pilot without an indication of attitude, against which contingency the compressed-air bleed from the turbojet compressor to the turn-and-bank indicator is one safeguard. While touching the subject of instrumentation it may further be observed that present methods of computing turbojet thrust are at best elementary, and new, accurate, thrust indicators may be looked for in the immediate future. Improved fuel flowmeters and contents gauges are being studied, and a dial indicating remaining time of flight may soon be added to the fighter's array of instruments.

With high priority, development is under way of light, compact, navigational aids for fighters and of equipment to enable large formations to be landed in a short time. Space for this gear must be found in the all-weather fighter and even the specialised intercepter may be required to carry a navigational aid. I.F.F. (identification, friend or foe) equipment continues to be required.

That discussion of the design and equipment of naval fighters should have been deferred until the conclusion of this review in no wise signifies under-estimation of their importance; but the Fleet fighter of to-day is so closely related to its opposite number ashore that, with the single qualification that sweepback is slower to come into its own in naval service, the foregoing survey of fighter design features applies in essence to naval types. There are, however, certain characteristics which must be emphasized for compliance with naval requirements. Principal among these are docility at take-off and landing, which may postulate greater wing area and more elaborate high-lift devices; the largest possible fuel capacity; and a wide field of view, especially over the nose. Whereas land-based fighters have wing loadings ranging from 55-80 lb/sq ft, naval types are commonly loaded to 35-50 lb/sq ft.

The designer of the Hawker Sea Hawk, depicted in a drawing on a preceding page has compared a naval fighter (presumed to approximate in weight and performance to the Sea Hawk) with a land-based machine, possibly similar to the P.1040, and quotes the following relative figures:

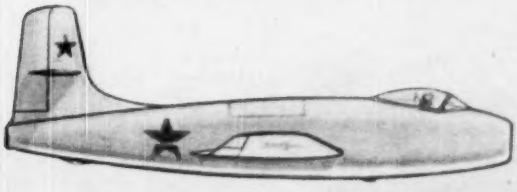
Land-based fighter		Naval fighter	
All-up weight	Max. Speed	All-up weight	Max. Speed
Over 11,000 lb	Over 600 m.p.h.	Over 12,000 lb	Approx. 600 m.p.h.

The same designer has further prepared the following table to convey an idea of the weight increases necessary to "navalize" reasonably similar piston-engined and jet fighters:

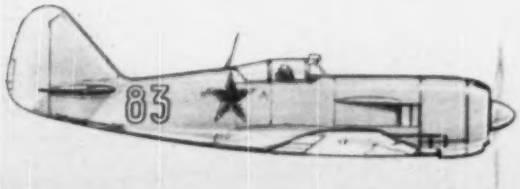
	Typical aircrew fighter (lb)		Typical jet fighter (lb)	
Wing				
Folding	170		176	
Flaps	—		170	
Increased area	—		42	
Strengthening	32		36	
Total		202		424
Fuselage				
Arresting	26		64	
Assisted take-off	26		35	
Strengthening	22		47	
Total		74		146
Undercarriage				
Increased absorption	20		61	
Strength	22		26	
Total		42		87
Operational Equipment				
Radio	35		83	
Navigational aids	5		88	
Electrical	22		23	
Miscellaneous	43		46	
Total		105		240
Total increase (approx.)		425		900

The absence of airscrew slipstream involves the use of special devices for the control of lift and drag during landing: on the Supermarine Attacker, for instance, the pilot approaches at a fixed throttle setting and controls the approach path by means of specially developed spoilers, extending them fully on being given the "cut" signal by the "batsman." Angle-of-attack indicators and stall-warning devices are now being installed.

Soviet single-jet fighter (possibly of Yak design).

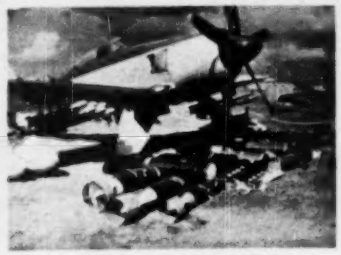


La-11 fighter, a widely used Soviet type.



Ground Attack

A D.H. Vampire 5 fighter-bomber simulating a skip-bombing run.



Possible loads of the Hawker Sea Fury.

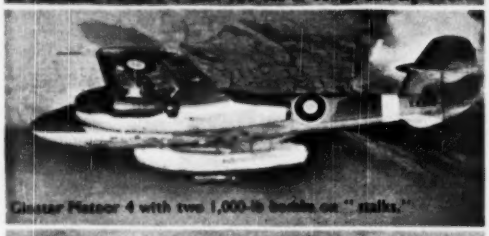
THE low-level attack aircraft most commonly in service are standard single-seat fighter-bombers, though the American Army has advocated development of specialized types and has investigated the potentialities of the Skyraider and Mauler dive-bomber/torpedo-carrier. These naval machines appeared especially attractive by virtue of their heavy and widely variable armament loads, but proved too slow for Army needs. The Soviet Ilyushin series of single-engined two-seaters, heavily protected by armour plate, and armed with large-bore guns, bombs and R.P.s, are the only truly specialized low-attack aircraft in service.

The English Electric Canberra, discussed at some length under the heading *Bombers*, is manifestly endowed with qualities necessary in a low-level "attack bomber," among which a high degree of manœuvrability at sea level is paramount. Though in the design of the American F-90 and F-88 fighters ground support was given special consideration, these types, if adopted for service, would be supplemented by specially designed tactical bombers in the class of the North American B-45 and Martin XB-51.

High fuel consumption at low levels is, of course, a severe handicap, but otherwise most present-day jet fighters are eminently suitable for attacks on pinpoint targets or military concentrations. They are certainly less vulnerable than wartime fighter-bombers powered with liquid-cooled piston engines. The pilot's field of view is good and there is no engine torque to affect aim, though at high speeds the aircraft are relatively sensitive to turbulent air. Cell-type tanks may be used to guard against total loss of fuel as a result of a hit.

Typical British and American fighters used for diving and low flying attacks are readily adaptable for carrying bombs, R.P.s, incendiary or anti-personnel clusters, napalm incendiary tanks, or smoke-curtain installations. The Hawker Fury takes any of the following loads, additional in every case to four 20 mm guns with 580 rounds: two 1,000-lb bombs; twelve 3in R.P.s (60-lb heads); twelve 5in R.P.s (60-lb heads); four R.P.s (180-lb heads); two 500-lb bombs and 2 R.P.s (180-lb heads); two clusters of anti-personnel bombs and two 45-gall drop tanks; or two smoke-curtain installations. The heaviest defensive loads yet carried by a jet fighter-bomber—the Thunderjet—are thirty-two 5in R.P.s, or twelve of these relatively small projectiles and two 11.75in, 1,200-lb "Tiny Tim" R.P.s, additional in each case to six M-3 guns (0.5in). Some flights have been made with the mixed R.P. load, tip tanks and J.A.T.O. assistance, at a weight of 24,000 lb. The Vampire 5 and Meteor 4 take two 1,000-lb bombs, or two 500-pounders and eight R.P.s.

It should be noted that, since the trajectories of normal aircraft guns and R.P.s do not coincide, the simultaneous use of both weapons is generally impracticable.

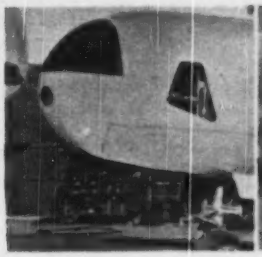


Gloster Meteor 4 with two 1,000-lb bombs on "stalks."

Below is the well-protected cockpit enclosure and dorsal 12.7 mm guns on a Soviet Il-2, of the type depicted at lower left.

Fighter Reconnaissance

The Hawker Fury, as shown above, is well suited for "Tac.-R."



Nose of Lockheed RF-80, showing (right) the camera installation

COLLECTION of intelligence for an army—especially through the medium of visual and photographic reconnaissance in the battle area—and the control of the fire of medium and heavy guns are primary tasks of the tactical reconnaissance (or, more descriptively, fighter reconnaissance) aircraft. Requirements include an endurance of two to three hours (this is difficult to attain with present-day jet fighters operating at low altitudes); high speed; heavy armament (according to British views, at least); a wide field of view for the pilot; provision for oblique, and probably forward-facing, cameras (in the use of these the smoothness of the jet aircraft is an important asset); and the latest low-level navigational equipment.

Versions of the Spitfire continue to give good service in the fighter reconnaissance role, but up to the present no jet aircraft to displace this type in R.A.F. service has been announced. An adaptation of the Meteor, which has a sea-level speed of 585 m.p.h., would appear suitable, but it must be recognized that the external tanks necessary on this and comparable fighters are very vulnerable to light flak.

A typical piston-engined fighter, the Hawker Fury, is provided with two F.24 cameras, one for vertical, and the other for oblique, photography. The lens of the vertical camera can vary in focal length from 5in to 20in, and that of the oblique camera from 8in to 20in.

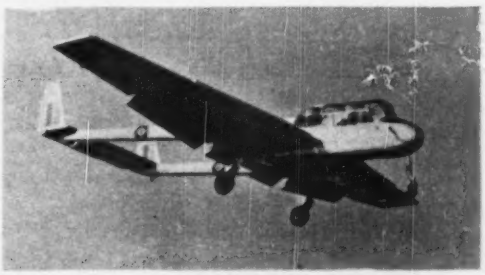
Spotting and Liaison

Boeing XL-15 (Lycoming 125-h.p.), in production for U.S. Army ground forces.

THOUGH possessing obvious advantages in the performance of various army co-operation tasks (among which casualty evacuation is not the least important), rotating-wing aircraft have not yet seriously challenged the specialized fixed-wing machines similar to those illustrated herewith. The range of duties for which such types are suitable is remarkably broad, and includes artillery spotting, photography, cable-laying, supply delivery, and ground-to-air pick-up. Requirements can be briefly stated as: unusually wide field of view for the pilot and observer; short take-off and landing runs; a good initial rate of climb; exceptional slow-flying qualities; and easy maintenance in the field. Some interesting high lift-devices are to be seen on aircraft of this class.

Variants of the Auster A.O.P. (air observation post) type, with Gipsy Major engine, remain standard equipment in the British forces, but to meet an army demand for an A.O.P. to carry more complete equipment, a heavier Auster was built to the A.2/45 specification. This machine is fitted with a 250 h.p. Gipsy Queen engine and has built-in leading-edge slots ahead of the slotted ailerons. Armour plate can be installed for certain duties and army radio is mounted on the pilot's instrument board. A hand-held F.24 or K.20 camera can be operated by the observer through hinged windows in the rear cockpit. A rate of climb of 740 ft/min and a take-off run, to clear 50ft, of 300 yd are reported, and the landing run—likewise from 50ft—is 275 yd. A highly interesting pusher-type aircraft was built by Heston Aircraft to the same specification. Full-span slotted flaps and leading-edge slots are features of this type, which flies at a gross weight of 3,050 lb.

A far lighter machine than the Auster A.2/45 (2,050 lb gross weight, against 3,365 lb) is the Boeing XL-15. This type, of only 125 h.p., clears a 50ft screen after a take-off run of 200 yd and lands over a 50ft obstacle in 175 yd. It can be quickly dismantled and loaded on a 2½-ton truck and, without having its airscrew removed, can be towed, glider-fashion, by another aircraft at speeds up to 165 m.p.h. Skis or floats are readily fitted.



Heston A.2/45 experimental A.O.P. aircraft (D.H. Gipsy Queen). Below: Auster A.O.P. aircraft to same specification as above. Right: Consolidated-Vultee L-13 (245-h.p. Franklin engine).

Bombers

Avro Lincoln (four Merlin) rearguard of the "Old Brigade."

Though Very Advanced Jet-propelled Types are Being Developed, Piston-engined Bombers Still Preponderate in the Air Forces of the Powers

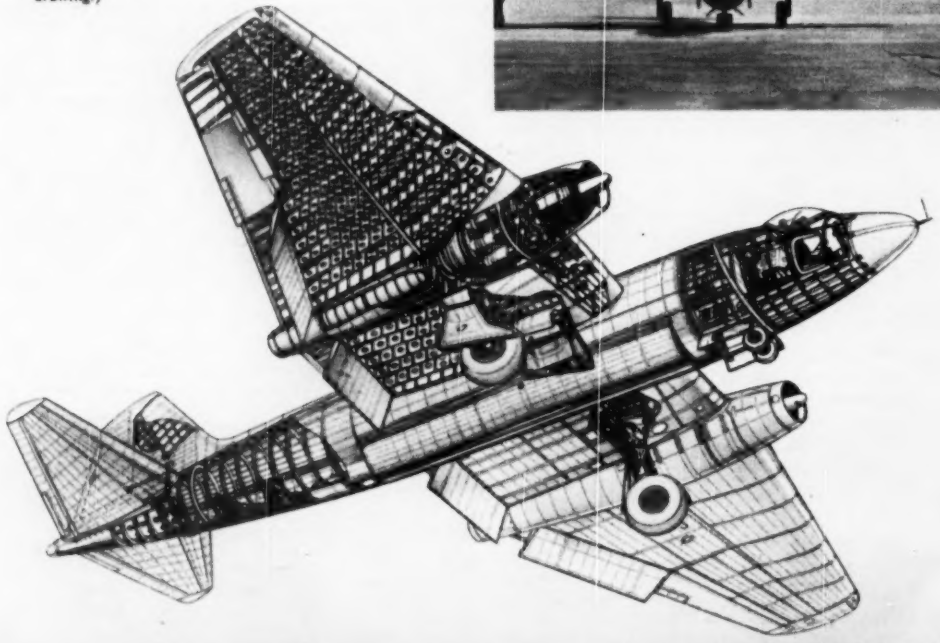
WHETHER bombers be graded according to range or as "strategical" or "tactical," there is a risk of obscuring their true status by the use of expedient terminology. The prefixes "light," "medium" and "heavy" are likewise unsatisfactory, unless duly qualified, for totally new values have been superimposed on the bomber picture. Recourse to such terms as "global" can further misguide the inquirer. It so happens that—unlike fighters—the bombers now in service or on test are so few that it is possible to enumerate those worthy of consideration on the fingers of both hands, enabling the principal types to be considered individually. Segregation of the jet from the piston-engined types is allowable and convenient.

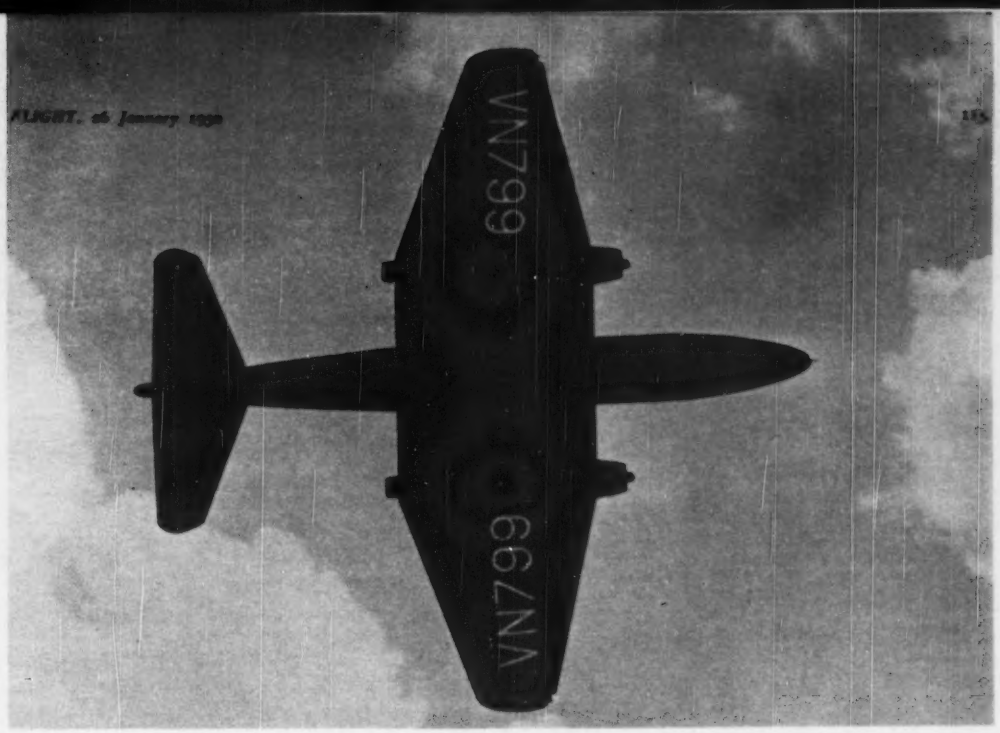
Bombers with piston engines as their primary source of power are: (a) the Convair B-36—abnormally large and heavy, with an exceptional bomb capacity and range; (b) Avro Lincoln, Boeing B-29 and B-50, and Tu-170—smaller, and with less capacity, but suitable, with flight refuelling, for very long-range operation; and (c) the so-called "tactical" bombers—exemplified by the Brigand, Douglas B-26, Tu-2, and certain Mosquito variants. All these types, with the addition of a small number of R.A.F. Mosquitoes equipped for target-marking, are in regular operation.

Of the jet bombers, only one—the North American B-45 Tornado, is known to be in squadron service; operationally it corresponds with the B-26 and Brigand. Others under active development are the versatile English Electric Canberra, now in production; at least two designs of Russo-Germanic conception; the army-support Martin XB-51; the Boeing XB-47 Stratojet (already being built in series), and—largest, and having the longest range, though not in quantity production—the Northrop YB-49 flying wing. Of

This frontal aspect of the Canberra scales with the views opposite.

A structural study of the English Electric Canberra B.I, Britain's first jet-propelled bomber.—(*Flight* drawing.)





Tractable, versatile, and of high all-round performance—the English Electric Canberra bomber (two Rolls-Royce Avon turbojets).

British designs later than the Canberra it can be said that one, at least, will be a four-jet type, comparable in performance with the English Electric bomber but having a longer radius of action. No bomber with turboprop power is known to be under development in any country.

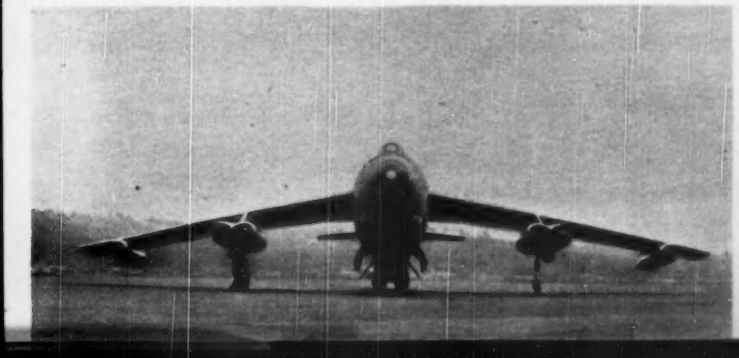
Piston-engined types now current (the B-36 and B-50 are the prime examples) will continue to serve for many years and accordingly are later examined in some detail. Of the B-36, now in regular squadron service with the U.S.A.F., more has been spoken and written in criticism and vindication than of any other aircraft—not excluding the Brabazon, an airliner of almost identical size, though of lighter gross weight. Space does not allow representation of all the theories, technical and tactical, propounded at the time of an American governmental inquiry into charges of irregularity in the purchasing of the B-36, but some piquant observations by "Favonius," in *Flight* of May 12th, 1949, are commended to the interested reader, with the proviso that he duly notes the verdict of Mr. Carl A. Vinson, chairman of the House Armed Services Committee—that "there has been very substantial and very compelling evidence that the Air Force has selected this bomber, and procured this bomber, solely on the grounds that it is the best aircraft for its purpose available to the nation to-day."

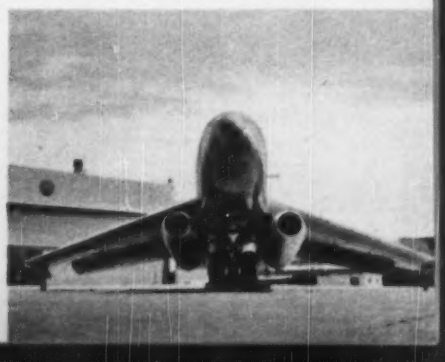
Criticism of the B-36 has stemmed largely from its supposed vulnerability to fighter action, but as so often proved true in military flying, theory has been shaken, if not shattered, by practical demonstration. It is true that the fighters matched against this bomber during trials last year were exclusively U.S.A.F. types, and, this being so, were not (as intimated in the preceding survey) distinguished for their performance at extreme height. Nevertheless, it is well to ponder the difficulties of destroying a high-altitude bomber, even though this might be flying—like the B-36—only moderately fast. First, there is the consideration that early-warning radar development appears to have fallen seriously behind aircraft progress, both in effectiveness and quantity available. No Power, in fact, is within sight of adequate provision for early-warning.

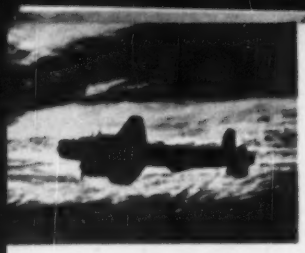
It may be assumed for our purpose, however, that a bomber has been located at 40,000ft. The next move, then, will obviously be the "scrambling" of the fighter and its direction on to the bomber, a procedure which, pending the general adoption of fighter-radar, is beset by manifold and serious problems, not the least of which is the fighter pilot's difficulty of making visual contact with the bomber and of determining its course. Although head-on attacks are feasible at 30,000ft, it is by no means certain that these will prove possible at our assumed level of 40,000ft or above, where, the bomber having highly supercharged piston engines, the jet fighter's margin of speed superiority may have seriously diminished.

With present-day fighters, stern or quarter attacks would be usual, placing the fighter (assuming that it has normal 20 mm armament) to the advantage of the defending gunners, not only in space, but ballistically also, for the bomber is a retreating target. It is recognized, of course, that the radar-equipped fighter, armed with homing missiles, will eventually put a very different complexion on the matter, in that, although remaining beyond the range

Boeing XB-47 Stratojet with its General Electric J-47 turbojets. Of the Martin XB-51's three turbojets, one is in the fuselage.

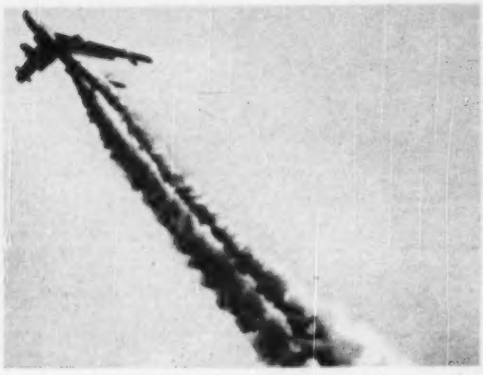






Bombers . . .

Martin XB-51 three-jet army-support bomber.



Rocket-assisted take-off by Boeing XB-47 Stratojet.

Parachute-retarded landing by Martin XB-51.

of defensive armament, it will nevertheless be able to destroy the bomber with greater certainty under any conditions of light or weather.

Obviously, a jet-propelled bomber, flying 100-200 m.p.h. faster than the B-36 or B-50, and at least as high, in order to attain its designed range, is an even more formidable adversary, while the low-level (and, therefore, relatively short-range) jet bomber, coming in to the target undetected by radar, is hardly less menacing.

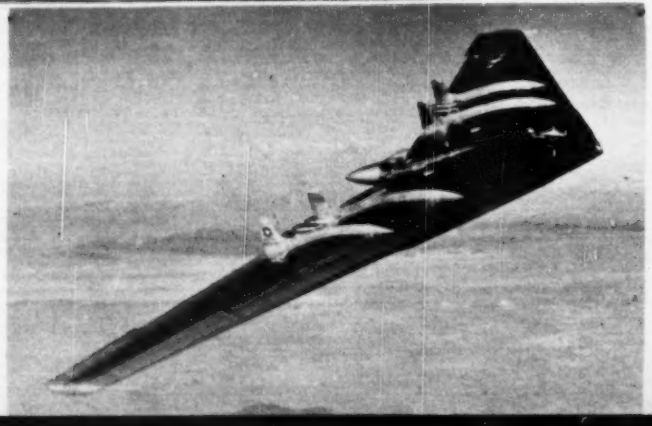
But the difficulties confronting the designer of the bomber itself are little less severe. Though at least one jet bomber prototype is already flying which has proved not only faster than jet fighters now in use, but capable of outclimbing them and of outmanœuvring them at height, it must be recognized that jet-bomber range and endurance remain seriously deficient, recourse to external tanks notwithstanding. Pending the development of special "bomber-type" turbojets, having a specific fuel consumption at cruising output 20 per cent or so below that of present units, a solution, or a partial solution, may be discovered in flight refuelling.

It is instructive to make an individual examination—of necessity somewhat superficial—of the newest types of jet bomber, for each displays some strongly defined peculiarity of design. As applied to the English Electric Canberra, the word peculiarity, perhaps, is not wholly appropriate, for the type is thoroughly rational in concept. Almost alone among modern bombers, however, it has a low landing speed and, furthermore, has publicly demonstrated true "fighter manœuvrability."

From the outset, a light wing loading, comparatively low aspect ratio, smooth structure and modest thickness/chord ratio were considered to be prerequisites in the design of the Canberra wing. Sweepback was deemed unnecessary at the Mach numbers attainable when carrying a useful military load and with the thrust likely to be available from the two Rolls-Royce Avan turbojets within the operational life of the aircraft. In practice, the critical Mach number of the wing has been very considerably exceeded, without the usual deterioration in stability.

Evidently the Canberra is amenable to adaptation for

Convair XB-46 (development abandoned).



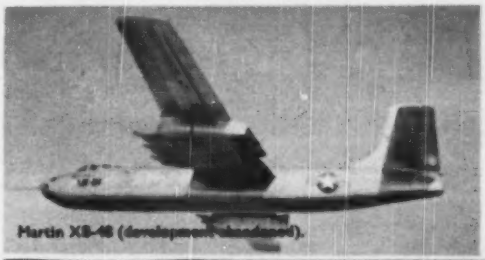
These two views afford an excellent comparison between the Northrop YB-49 eight-jet all-wing bomber (left) and its piston-engined precursor, the XB-35 (below). Note that elimination of propellers has necessitated fin area.

Back-swept vertical and horizontal surfaces, fine fuselage form and outrigged jet "pods" are all visible in this study of the Stratojet.

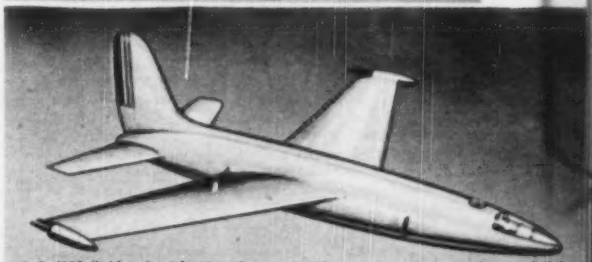
high- or low-level bombing and for target marking. Stowage of fuel in the wing, as well as in the fuselage and wing-tip drop-tanks, should prove possible. The bomb load may not be disclosed, but the retractable bomb-bay doors are 22ft 3in long. On the B.1 variant at least, no armament is installed, the aircraft relying for defence on its speed and exceptional manœuvrability.

A very different picture—though a highly interesting one—is presented by the new Martin XB-51—a truly specialized type, designed principally, if not solely, for low- and medium-level assault on military targets in co-operation with air-ground and/or naval forces. Like the Canberra, it carries a crew of two; but here the affinity ends. As an indication of proportions it may be remarked that the 55ft wing (with 35-deg sweepback) approximates in span to the Mosquito, while the fuselage length is actually 6ft longer than the Hastings 50-seat troop carrier! Nevertheless, the XB-51 is considered by its makers to be "the smallest and lightest airplane available which is capable of meeting the present requirements of the U.S. ground forces and Air Force for adequate ground support."

The XB-51 wing has a marked droop when the aircraft is stationary and is provided with variable-incidence gear, pivoting on the rear spar and allowing take-off and landing in a near-horizontal attitude. Thus, the two double main-wheel undercarriage units (both of which retract into the fuselage and account in part for its singular bulk) can take the landing load simultaneously. Both take-off and landing speed benefit from this arrangement but are nevertheless



Martin XB-48 (development abandoned).

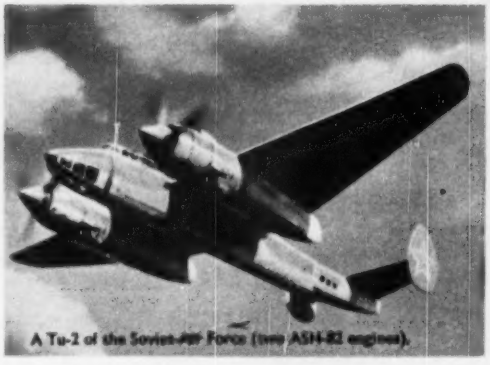


S.O.4000 (2 Nene) with wing-tip armament.

North American B-45 Tornado (four J-33 turbojets).

Bombers . . .

Bristol Brigand B.1 with two 18-cylinder Centaurus engines.



A Tu-2 of the Soviet Air Force (two ASH-82 engines).

A 12,000-lb bomb is released from a Boeing B-29.

very high, necessitating recourse, in the least favourable conditions, to rocket assistance and a braking parachute. Lateral control is effected by spoilers, and slotted flaps of large area extend over most of the span. There are air brakes on the aft fuselage section and the horizontal tail surfaces are mounted atop the fin, clear of the worst of the turbulence created by the wings and forward jet units.

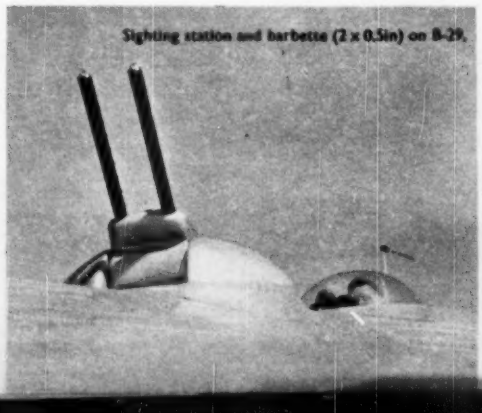
Of the three General Electric J-47 axial-flow turbojets, each, with liquid injection, of over 5,200 lb thrust, two are mounted on pylons jutting from the lower forward fuselage, and the third is internal in the rear fuselage, where it is fed by a long dorsal duct, the intake to which can be closed when the power unit is inoperative.

Although bombs (of up to 12,000 lb total weight) will form the primary armament of the XB-51, provision has been made for eight 20 mm or four 75 mm guns to be mounted in the nose. A speed of at least 600 m.p.h. should be attainable, and the gross weight has been estimated at 80,000 lb—roughly that of the Avro Lincoln.

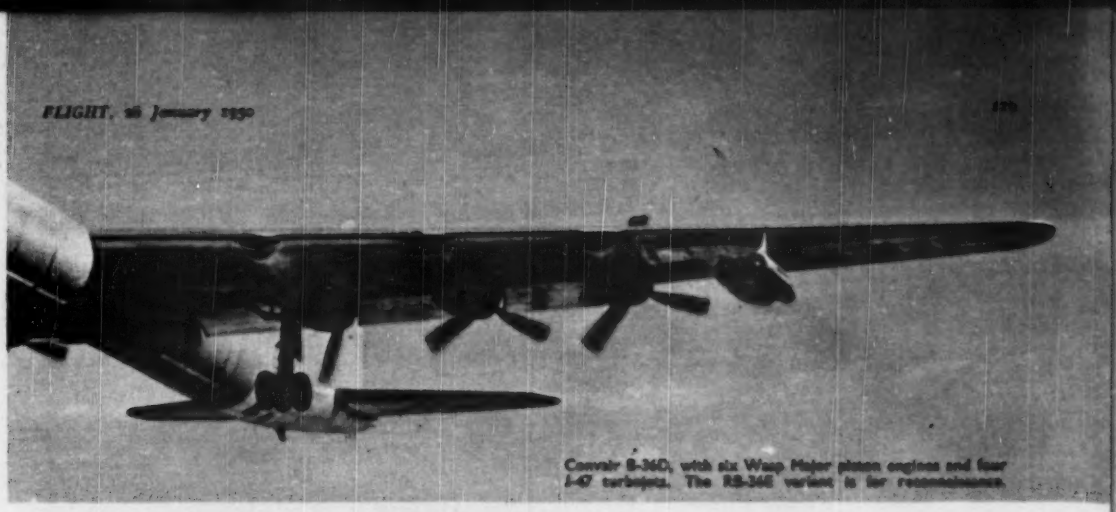
Less modern in design—the prototype having flown some three years ago—the North American B-45 Tornado four-jet bomber, with which some U.S.A.F. squadrons are already armed, is an 83,000 lb type, of relatively short range (tactical radius is quoted as "more than 800 miles"), having a maximum bomb load of 20,000 lb and a tail armament of two 0.5in guns. Unlike the Canberra, the Tornado has powered controls. At 70.3 lb/sq ft, the wing loading is moderate, according to American standards at least, and as in all U.S. jet bombers, the crew (numbering four) have ejector seats. Together with a Soviet Ilyushin bomber with four underslung axial-flow turbojets (and for that matter, a twin-jet Tupolev also), this useful American machine represents a stage of transition between the fastest piston-engined bombers and the truly modern jets.

Although larger and faster and having a longer range than the Tornado, the Boeing B-47 Stratojet, the first prototype of which flew towards the end of 1947, carries the same bomb load. For the present the gross weight is in

Boulton Paul tail turret, with AGL, on Avro Lincoln.



Sighting station and barbette (2 x 0.5in) on B-29.



Convair B-36D, with six Wasp Major piston engines and four J-47 turbojets. The RB-36E variant is for reconnaissance.

Boeing B-50D, with four Pratt and Whitney Wasp Majors.

the region of 125,000 lb, but this will ultimately be increased to 180,000 lb or more., representing a wing loading of the order of 140 lb/sq ft; little wonder that, built into the rear fuselage, are two groups of nine A.T.O. rockets, providing a total emergency thrust of 18,000 lb. The turbojet thrust of the initial production version (B-47A) with six General Electric J-47 turbojets (installed in nacelles outrigged from the extremely thin 35-deg-swept-back wing) will total 30,000 lb. For quick stopping the B-47 utilizes a 30ft. ribbon-type parachute and, in common with the three-jet Martin, is has a tandem-type main undercarriage, retracting—necessarily with prejudice to fuel tankage—into the fuselage. The only official intimation of range is "over 2,000 miles with ten tons of bombs"; thus flight refuelling may prove essential. All three members of the crew are accommodated in a pressurized and temperature-controlled cabin forward of the wing, the light tail armament being remotely controlled. Blind-bombing radar is installed in the lower forward fuselage, to the rear of the bomb aimer's position.

Indicative of the Stratojet's capabilities was a flight of 3 hr 46 min during February last year, when the 2,289 miles from Moses Lake, in Central Washington State, to Andrews Air Force Base, Maryland, was covered non-stop at an average speed of 607.8 m.p.h. In overall dimensions the Stratojet is roughly equivalent to the piston-engined B-29 Superfortress, the span being 116ft and the length 108ft. Its formidable weight notwithstanding, the type is classed by the U.S.A.F. as a "light" bomber.

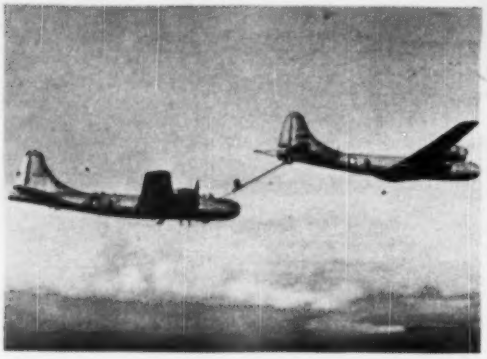
Although contracts for the Northrop B-49 flying-wing jet bomber, and experimental sub-types, have been progressively reduced, the type continues to demand attention by reason of its advanced aerodynamic and structural design. One example is being adapted for the flight-testing of Northrop turboprop units, but development has been concentrated on variants with eight (or, more recently, six) turbojets, and having a speed well in excess of 500 m.p.h.

The manufacturers claim for the flying wing a superiority

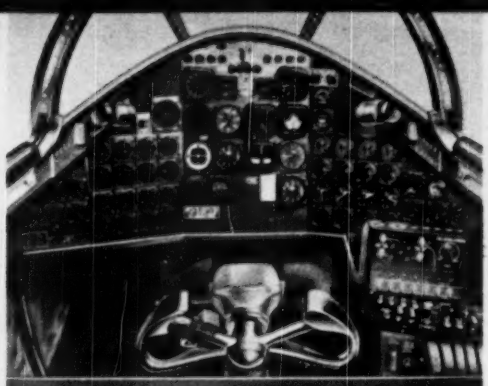
Tail gun position (with AGL) on Boeing B-29.

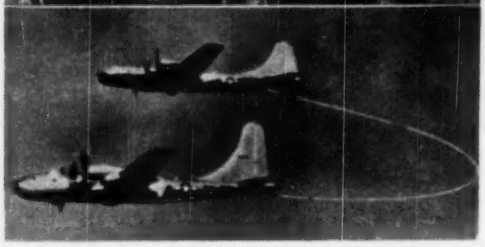
Empennage and tail gun position, B-36.

Bombers . . .



B-29 Superfortresses demonstrate the Boeing-developed "flying-boom" refuelling technique, whereby the rigid boom is "flown" by the operator through the medium of small aerofoil surfaces.





The uppermost view shows the cockpit of the North American Tornado jet bomber. Below it is depicted the British Flight Refuelling technique (B-50 receiver with B-29 tanker).

over conventional large airframes in respect of drag reduction, increased range and speed, and weight-lifting ability. Since the weight is distributed along the span, a relatively light structure is possible, and this accounts for the very favourable ratio of gross weight to empty weight (213,000 lb : 88,100 lb) of the B-49, as powered with eight J-35 turbojets. Provision is made for a crew of seven (pilot, co-pilot, navigator, radio operator, flight engineer, bomb aimer, and gunner) in this 172-ft flying-wing bomber, described by the U.S.A.F. as "the world's longest-ranging jet aircraft." On the score of range it can be recorded that a YB-49 prototype has flown non-stop for 3,458 miles at an average speed of 382 m.p.h.

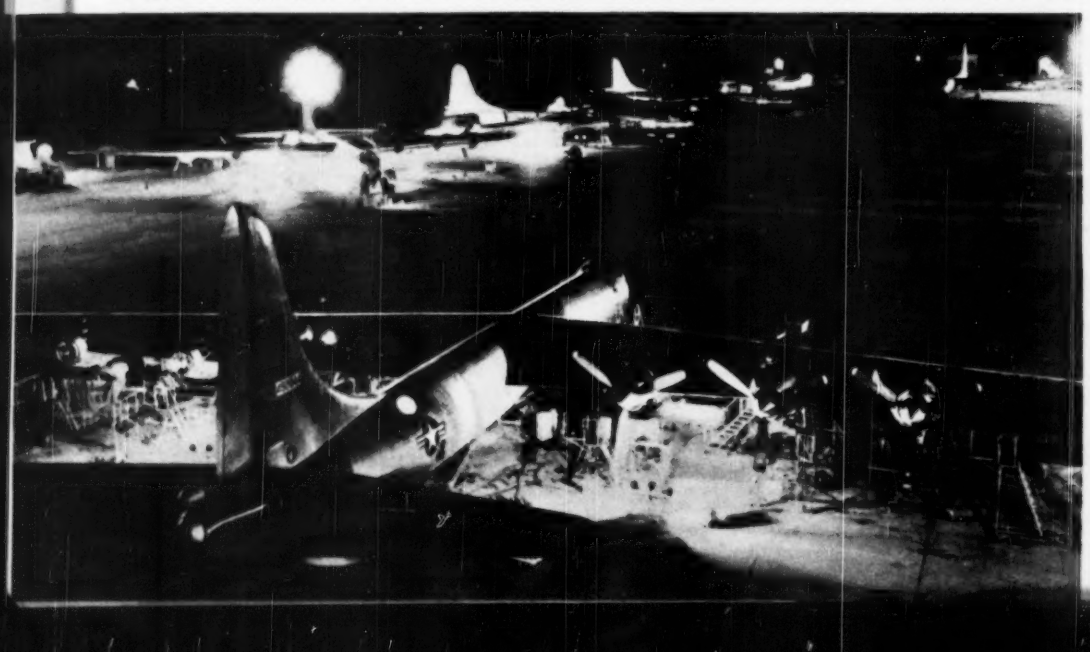
Uncertain as the future of this form of flying-wing bomber appears, there is good reason to suppose that true delta-wing bombers are already on the drawing boards, and that some designs may favour other wing configurations, including, perhaps, the "crescent" form.

America's newest jet bomber project is the Boeing XB-52, which is still in the mock-up stage, though two prototypes are on order. Following B-47 lines, even in having outrigged jet "pods" and a "bicycle" undercarriage, this type will be appreciably heavier (the gross weight is rumoured to be approximately 250,000lb) but, nevertheless, of higher performance.

Of operating techniques for jet bombers a great deal remains to be discovered and proved. Cruising at 40-45,000ft these aircraft can more than double their sea-level range and it will normally be necessary for them to climb to optimum height straight from take-off, and to remain there as long as possible.

Modern piston-engined bombers are similarly operated at high levels, not only for maximum economy but in order to handicap opposing fighters and anti-aircraft guns. Heights between 35,000 and 45,000ft are considered normal for the B-36, and the B-50, which, in its present form, has an absolute ceiling of 40,000ft, can cruise at 30-35,000ft. At 25,000ft the cabin altitude is 5,500ft. The B-29, forerunner of the B-50, and the so-called Tu-170, the Russian copy of the B-29, are capable of sustained cruising at heights between 25,000 and 35,000ft. Like the Avro Lincolns of the R.A.F., the American and Soviet bombers

B-36 bombers being prepared by night at the Fort Worth, Texas, plant of Consolidated Vultee, for delivery to U.S.A.F. units.



named would normally attack by night, or through overcast.

Of the piston-engined bombers, the Convair B-36 commands pride of place, if only by virtue of its bulk and technical interest. Space will not allow a review of its development through successive phases, culminating in the sub-type D, now current, but it may be recorded that the "X" prototype first flew in August, 1946. The B-36D has a maximum gross weight of 326,000lb and, like its predecessors, measures 230ft in span; the cost-price is four million dollars. Supplementing six Pratt and Whitney Wasp Major 24-cylinder piston engines, driving 19ft pusher propellers, are four General Electric J-47 axial-flow turbojets, suspended on two "stalks" from the outer wing panels. Abandonment of a projected version with Wasp Major VDT (variable-discharge-turbine) compound engines driving tractor airscrews was ascribed to the undue amount of redesigning necessitated and to the undeveloped state of the engines.

Additional to a normal crew of fifteen there is a four-man relief crew; all are enabled to travel from the forward to the aft pressurized cabin through what has been described as the largest airborne tube railway in the world—an 85ft-long tunnel with tracks for a 4-wheel truck. The four bomb bays have a volume of 12,300 cu ft, and although the bomb load originally specified was 10,000lb (to be carried for a range of 10,000 miles), the maximum possible load, for reduced range, is, in fact, 84,000lb. A B-36B (an earlier version without turbojets) has flown 10,500 miles without refuelling, releasing 10,000lb of bombs at the half-way point. On another occasion a similar machine flew more than 7,100 miles—6,000 of them at a height of over 40,000ft, and at an average speed of 300 m.p.h. The B-36D, with turbojets, is said to be capable of better than 400 m.p.h. at heights above 40,000ft, and the intention is reported of progressively improving performance until 500 m.p.h. is attained at 50,000ft. The greatest height so far achieved (with light load) is 47,500ft. A projected version, having thinner, swept-back, wings, and powered with Allison T140 turboprop units, has been rumoured.

Contemporary with the B-36D, the Boeing B-50D is powered by four Wasp Major engines, has a gross weight of 164,500lb, and a stated maximum speed of more than 400 m.p.h. Range is now quoted as "approximately 6,000 miles with ten tons of bombs." This is made possible by the addition of two jettisonable 580-gallon external fuel tanks, the attachments for which can alternatively be used to carry two 4,000lb bombs, bringing the total bomb load to 28,000lb. Equipment for flight refuelling is now standard, and in this connection it may be mentioned that the Boeing Company has been experimenting with the so-called "flying boom" method, in which a refuelling boom extends under the tail of the tanker and is controlled in space by small V-shaped "ruddervators." Telescoping tubes enable it to be retracted or extended. Though various claims are made for this system there is reason to believe that it has not proved entirely satisfactory. The British flexible-hose system was used in February last year when the B-50 *Lucky Lady II* flew round the world non-stop, having been refuelled in flight by B-29 tankers at four points on its 23,452-mile route.

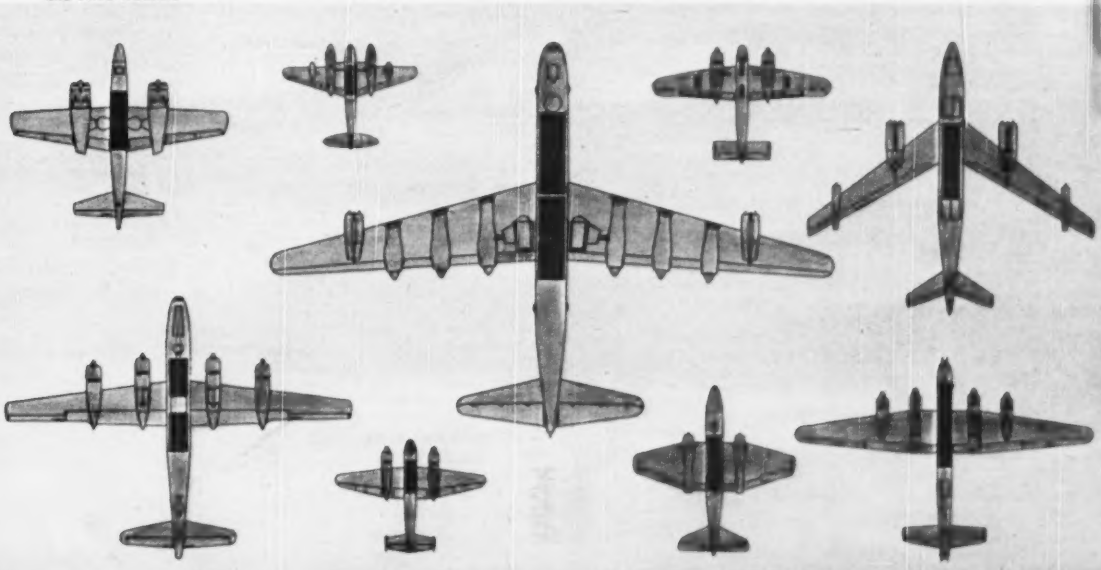
Concerning the precision with which modern bombers can deliver their load, little can be said, the latest developments in bomb-aiming technique being secret. It is known, however, that in post-war tests from medium and high altitudes British bombers have employed stabilized automatic sights, with the aircraft under manual control, and that B-29s, using the Norden sight, have been controlled, by the bomb-aimer, on their run-up to the target, by means of an automatic pilot. Needless to say, the modern bomb-sight is an instrument of amazing sensitivity, complexity and—unhappily from the maintenance standpoint—delicacy also.

As a blind-bombing and navigational aid, British bombers are equipped with H2S4A, a post-war development of the original H2S, which played its part in the devastating Bomber Command attacks of the later war years. In brief, this radar device produces a fan-like wave formation, narrow in the horizontal plane but broad in the vertical plane. Once every second the scanner rotates; the narrow band sweeps the ground and ground features are recorded on a cathode ray tube, presenting a "map" of the area beneath the bomber. Ground speed and wind speed are readily calculated. A switch gives four variations in the scale of the area covered by the scanner (1-in-250,000, 1-in-500,000, 1-in-a million and 1-in-two million), these proportions corresponding with the maps employed.

For the navigation of jet bombers (and, for that matter, fighters likewise) automatic instruments are being developed. Among the first of such devices was the German *Kurshoppler*, which gave continuous indication of ground position relative to a fixed starting point.

Even in its war-time form the B-29 carried nearly 2,000lb of radar and radio equipment, including radar for naviga-

The collation of views below serves to indicate the relative sizes of representative bombers and the extent of their bomb bays. Uppermost are the de Havilland Mosquito and—with external stowage—the Bristol Brigand; centre (l. to r.) the North American B-45 Tornado, Convair B-36 and Boeing XB-47; and, in the bottom row, (l. to r.) Boeing B-50, Tupolev Tu-2, English Electric Canberra and Avro Lincoln.



Bombers . . .

tion, blind bombing and identification, and radar countermeasures equipment, together with all normal radio equipment and a few non-standard items. The weight and bulk of this gear presented acute problems, but in the newer B-50, aircraft and electronic design teams have collaborated to better effect, and the difficulties have been more satisfactorily met. Flush aerials reduce aerodynamic drag. Improved blind-bombing equipment, a central fire-control system for the multiple barbettes, and various radio and radar aids have been estimated to account for more than half the total cost of a B-50 bomber.

It must be remembered that the complicated electronic and other aids which are part and parcel of the modern bomber are solely a means of delivering a bomb load with certainty and accuracy. Of the bombs themselves, as of the means of their delivery, little of a factual nature can be written. It can, however, be emphasized that, contrary to popular belief, atomic bombs have exercised very little influence on bomber design. A deep, rather than an inordinately long, bomb bay is probably required for weapons of this type now available. The Boeing B-29 (and its Soviet counterpart, the Tu-170), the B-50 and the B-36 are certainly able to handle atomic bombs, as are various U.S. Naval aircraft, including the Neptune and Mercator. There is no reason to doubt that the Avro Lincoln is adaptable for the purpose, and that later British long-range bombers have been designed with atomic warfare in mind.

Typical bombs charged with conventional high explosive include high-capacity (4,000 and 8,000lb); anti-submarine (100-500lb); general-purpose (500 and 1,000lb); semi-armour-piercing (500lb); armour-piercing (2,000lb); anti-personnel (20-40lb); and incendiary (4-250lb). In addition to, or as alternatives to, these, a large bomber might be required to lay mines or drop target indicators, photographic flash bombs, flares, smoke floats, smoke generators, sea markers and flame floats.

Twelve-thousand-pound and 22,000-lb deep-penetration bombs of British origin achieved notable results in the late months of the war and were subsequently tried out, parallel with a 4,500-lb rocket-assisted bomb, against the Farge U-boat pens. At Muroc, tests have been made, using a modified B-29 as carrier, with a 42,000-lb bomb, having a body diameter of 4½ft and a length, over fins, of 26ft 10in. Designed for the U.S.A.F. early in 1945, this is classed as a general-purpose bomb. Though lacking the destructive power of the atomic weapon, such a bomb has the advantage that it leaves no radioactivity which might delay consolidation of a captured area by the attacking force.

A graphic comparison of a 22,000 lb bomb with a 2,000-pounder.

Radio control in range and azimuth has been applied to 1,000 lb and 12,000 lb bombs and is intended for a 22,000-pounder. In common with controlled bombs of German origin these bombs have flares in the tail to allow the bomb-aimer to keep track of their path. Since the existence of the Roc high-angle television/radio-controlled bomb was disclosed shortly after the war, little information on this and similar weapons has been authorized by the U.S.A.F.

In common with bombing gear, defensive gun installations become increasingly complex. Even the relatively old and, according to current standards, light, Avro Lincoln—the standard "heavy" bomber of the R.A.F.—has an armament of twin 0.5in guns in a Boulton Paul Type F nose turret, two similar guns in a Boulton Paul Type D tail turret, and two 20 mm Hispano guns in a Bristol B.17 mid-upper turret. The front guns are remotely sighted and fired by the bomb aimer from his station beneath the turret, and the dorsal and tail turrets are directly manned. In addition, the tail turret is equipped with the AGLT device (AGLT = assisted gun laying turrets)—a radar scanner, with beam parallel to the bore of the guns, which apprises the gunner of the position of an unseen fighter with sufficient accuracy for him to open fire. It is further valuable in allowing the bomber pilot to take appropriate evasive action. A development of the AGL scheme aims and fires the guns automatically, leaving the gunner the tasks of identifying and selecting his target.

The normal armament of the Boeing B-50D, as now in regular service with the U.S.A.F., is thirteen 0.5in guns—ten in four remotely controlled, electrically operated barbettes (two above the fuselage and two below), and three in the tail position. In the forward upper emplacement is an improved type of four-gun barbette; a two-gun installation is located just forward of the fin, another in the forward lower position, and a fourth just ahead of the tailplane. There are no fewer than five sighting stations—one in the nose, three in the central (pressurized) compartment, and one (with AGL) in the tail. From these positions barbettes are controlled as follows:—

Sighting Station(s)	*Barbette(s) Controlled*
Mid-upper.	One or two upper.
Sides.	Lower rear.
Fuselage nose.	Lower front.
Tail.	Tail.

Though from some stations secondary control can be exercised over barbettes other than those enumerated above, the controlling mechanism is so arranged that only one sight can traverse and fire a given barbette at one time.

Various schemes for arming the Convair B-36 have been prepared, that adopted for the "B" variant utilizing sixteen 20 mm and one 37 mm guns. Twin 20 mm installations are located in the extreme nose; at two positions on top of the fuselage; two positions below the fuselage; two positions at the base of the fin; and one tail position. This last incorporates the 37 mm gun. Remote control from sighting blisters is employed throughout, and all barbettes (other than nose and tail installations) are retractable.

Bomber defence is not necessarily in the form of guns. Grenades were experimentally (and ineffectually) discharged from German bombers during the war, and the possibilities of "parasite" fighters, to be carried by the largest types of bomber, have been investigated. Although Great Britain showed the way in October, 1926, when two Gloster Grebes were air-launched from the airship R-33, America has conducted the only parasite experiments in recent times, using a McDonnell XF-85 jet fighter, stowed semi-internally in the bomb bay of a B-29. The tiny defender (span 21ft) was launched from, and re-engaged with, an external trapeze. After initial difficulties, several successful launches and hook-ons were effected.

Strategical Reconnaissance

The Republic XR-12, capable of cruising at 400 m.p.h. at 40,000ft.

IT is a curious fact that, notwithstanding the cardinal importance of photographic reconnaissance, no "P.R." aircraft to succeed the war-time Mosquito and Spitfire in R.A.F. service has yet been announced. The Meteor jet fighter, however, is adaptable for armed or unarmed reconnaissance over relatively short distances, and the English Electric Canberra jet bomber has the earmarks of a first-rate machine for medium-range work. In the Sea Hornet P.R.22 the Royal Navy has a useful type, provided with two F.52 cameras for day reconnaissance, or one Fairchild K.19B for night work.

In America two specialized, piston-engined long-range photographic reconnaissance aircraft—the Hughes XF-11 and Republic XR-12—have been built and tested, but no production orders have been placed. The Northrop RB-49, reconnaissance variant of the all-wing bomber, was also considered by the U.S.A.F., but again, no orders have been forthcoming. Instead, a modified version of the B-36 bomber (RB-36E) will be used for strategical reconnaissance and will be supplemented by North American RB-45s (adapted B-45 jet bombers) and a number of Boeing RB-50s, likewise bomber adaptations. Using the U.S. Navy's CA-8 cartographic camera, mounted in a McDonnell Banshee, remarkably clear pictures of Washington have been secured from a height of 51,089ft (sic).

During 1948 a Republic XR-12 recorded a continuous picture during a 7-hr flight from the Pacific to the Atlantic, using 325ft of film and taking a total of 390 individual photographs. This flight—made at an average speed of 375 m.p.h. at 40,000ft—was a test for the tri-metrogon K.17 camera, consisting of three 6in cameras positioned so that their simultaneous operation recorded the terrain from horizon to horizon across the line of flight. From 40,000ft, horizon-to-horizon coverage was 490 miles.

A Short Sunderland reconnoitring at low level.

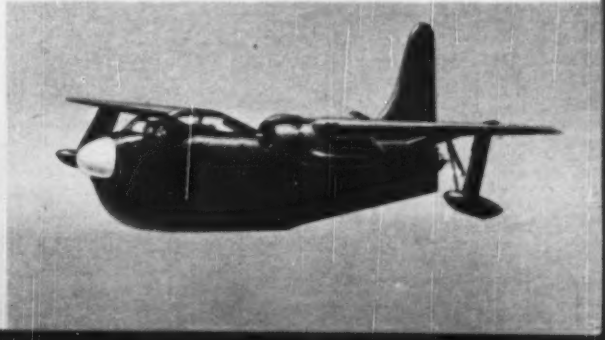
Sea Reconnaissance

FOR locating, shadowing and attacking surface vessels and submarines by day and night, specialized landplanes and flying boats have been developed. In any future conflict one of their primary functions would be that of denying submarines the freedom to operate on the surface. Known in Great Britain as general reconnaissance, or maritime reconnaissance, aircraft, and in the U.S.A. as patrol bombers, these are long-range machines, intended for low- or medium-altitude operation, carrying heavy offensive armament in the form of bombs, depth charges or other anti-submarine weapons, and lavishly provided with search radar and special devices, the newest of which, being intended to counter the latest schnorkel-equipped, high-speed submarines, are of a secret nature.

General reconnaissance squadrons of the R.A.F., at present equipped with ageing Short Sunderland flying boats and adapted Lancaster bombers, are to be rearmed with the Avro Shackleton landplane, which, though utilizing certain components of the Lincoln bomber, has a totally new and larger fuselage to provide for the crew of ten and special equipment. There is a search position in the nose, affording a very wide field of view, and numerous observation windows. A tail-wheel undercarriage was selected in order to obtain the maximum utilization of space in the nose for operational equipment, and to facilitate bomb stowage. The bomb bay is of exceptionally large dimensions, and a heavy defensive armament—two 20-mm guns in remotely controlled nose barbettes, two 20-mm in a dorsal turret and two 0.5in in a tail turret—was originally fitted, but the dorsal and tail turrets have now been deleted. The four Rolls-Royce Griffon piston engines have been developed with special

Constellation adapted to test "advanced electronic systems."

The Martin P5M-1, as ordered for the U.S. Navy.



Sea Reconnaissance

regard to economy of operation under cruising conditions.

A landplane, such as the Shackleton, possesses the important advantage that radar can be installed in the lower fuselage. Since the Short Seaford (military counterpart of the civil Solent) and the larger Shetland were built, no reconnaissance flying boat has been developed in Great Britain, though, as will later be seen, interest in this class is maintained in America.

The Lockheed P2V Neptune, a standard shore-based patrol bomber of the U.S. Navy, is twin-engined and considerably smaller and lighter than the Shackleton; the normal gross weight is, in fact, 58,000 lb, but a special P2V—the *Truculent Turtle*—was loaded to 85,000 lb and set up a world's record with a non-stop flight of 11,235 miles. Carrying service load, the standard P2V has a still-air range of more than 3,500 miles. Typical bomb loads are 16 x 500 lb, 8 x 1,000 lb, or 4 x 2,000 lb; alternatively, 12 x 325 lb depth charges, two torpedoes, sea mines, or a number of 11.75 in "Tiny Tim" R.P.s can be handled. Additionally there is under-wing provision for sixteen 5in R.P.s, and a fixed nose armament of six 20-mm guns. Twin 0.5in guns are mounted in a dorsal turret, and two 20-mm guns in the tail. The later P2Vs have a sonobuoy installation, and the fitting of Wright Turbo Cyclone compounded engines is intended as a means of further extending range. Having been rocket-assisted off an aircraft carrier, a Neptune last year flew 2,000 miles, released a 10,000-lb bomb load and continued for a further 2,000 miles.

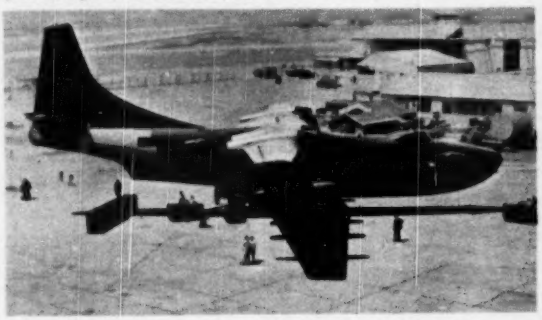
Of higher performance than the Neptune, the 80,000 lb Martin P4M-1 Mercator has two J-33 turbojets additional to, and sharing the same nacelles as, two Wasp Major piston engines, and attains a top speed of about 350 m.p.h. The turbojets are used for take-off and for closing on a target, but cruising on piston engines alone a maximum range of over 3,000 miles is possible. Although "schnorkel"-equipped submarines would generally be submerged at the time of attack, the Mariner is, nevertheless, generously provided with anti-flak armour.

Martin Mariner flying boats and amphibians continue to be used by the U.S. Navy, and an improved version—the P5M-1—with a full-length planing bottom, is under development. Advanced hull form is also a characteristic of the new turboprop-powered Convair XP5Y-1.

Lockheed P2V Neptune over Alaskan terrain.

Martin P4M-1 Mercator, with two Wasp Major piston engines and two J-33 turbojets sharing the same nacelles.

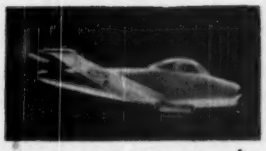
Convair XP5Y-1 60-ton long-range, high-speed flying boat, to be powered by four Allison turboprops.



Prototype of the Avro Shackleton general reconnaissance aircraft (four Rolls-Royce Griffon engines), intended for Coastal Command

Naval Strike and Anti Submarine

A Fairey Firefly makes a wave-top getaway after a mock attack on H.M.S. Anson.



Projected Breguet anti-submarine aircraft.

WHEREAS it has hitherto been usual to adapt deck-landing strike aircraft for anti-submarine operation, there is now a tendency to develop types with submarine warfare specifically in mind, though these are capable of performing in other roles. Of such aircraft Great Britain can show, in the new Blackburn Y.A.5 and Fairey 17, two outstanding examples. Regrettably, nothing can be said of these prototypes other than can be learned from the photographs herewith. The power plant of the Fairey machine is an Armstrong Siddeley Double Mamba turboprop, which comprises two entirely independent Mambas, each capable of being started, operated or stopped separately from the other. For the present, the Blackburn Y.A.5 has a Rolls-Royce Griffon piston engine, but is intended for turboprop power. A capacious bomb-bay is in evidence.

Unremitting research is being directed towards the mastery of the fast modern submarine, which is enabled by its "schnorkel" breathing tube to remain submerged for protracted periods with scant likelihood of detection. Of the problems attending the design of carrier-borne anti-submarine aircraft, that of reconciling an adequate depth charge, R.P. or bomb load with provision for search equipment in the form of internal radar and/or sonobuoys is especially difficult. Radar remains bulky, heavy and elaborate, and sonobuoys are effective only in large quantities. It is generally necessary, with the smaller types of carrier-borne aircraft, therefore, for some to operate as detectors and others as "killers."

To position itself to strike immediately its target is located, the anti-submarine aircraft must possess good manœuvring—especially turning—qualities.

The potentialities of helicopters for anti-submarine warfare are "under active consideration" in Great Britain and the U.S.A.

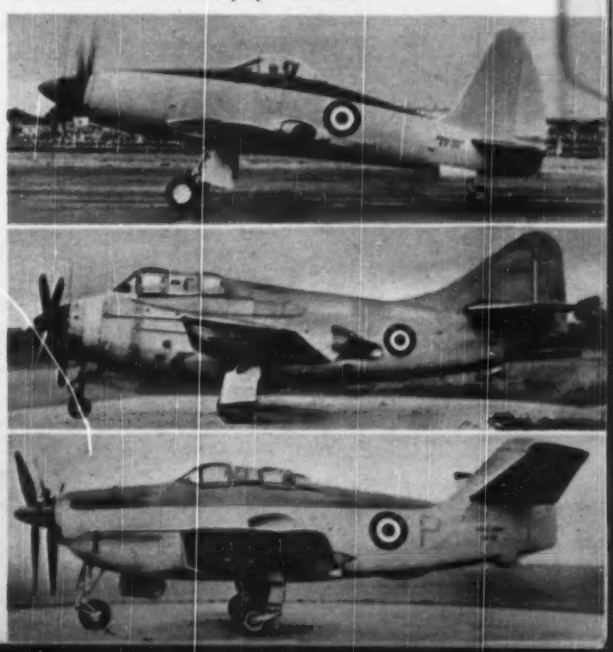
A projected Breguet anti-submarine machine has a turbo-jet unit in addition to a Double Mamba. Pure-jet aircraft would, of course, be handicapped by relatively short endurance at low altitude, but it is known that the Douglas Skyknight twin-jet, all-weather naval fighter and the French V.G. 90 are adaptable for bombs or rocket projectiles.

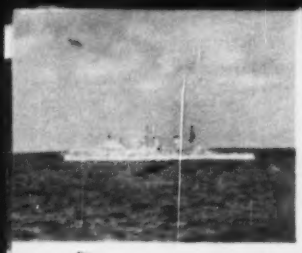
As a replacement for the Blackburn Firebrand in service with the Royal Navy, a quantity of turboprop-powered Wyvern T.F.2 torpedo fighters has been ordered from the Westland Aircraft Co. Concerning the performance characteristics of this mark of Wyvern little can be said, but an earlier version, with a Rolls-Royce Eagle 24-cylinder piston engine, attained a maximum speed of 455 m.p.h. Armament is quoted as one 20in torpedo or one 2,000 lb bomb, or eight 60 lb R.P.s in addition to four 20 mm wing-mounted guns. The Armstrong Siddeley Python turboprop of the Wyvern T.F.2 drives an eight-blade Rotol contra-rotating airscrew, and the small dimensions of the Python have enabled the Westland designers to provide an excellent forward and downward view over the nose for deck-landing and for diving attacks. The bifurcated jet-pipes emerge on each side of the fuselage below the cockpit, slightly to the rear of the pilot's seat.

With the great power at its command, and with its extremely clean aerodynamic design, the Wyvern is obviously of higher performance than the Douglas Skyraider and Martin Mauler single-seat strike ("attack") aircraft now serving with the U.S. Navy, though, as will now be made clear, these types possess many desirable features.

In no naval aircraft is the quality of versatility more pronounced than in the two-seater Fairey Firefly, adopted not only by the Royal Navy, but by Canada, Australia and the Netherlands. Originally categorized as a fighter reconnaissance aircraft, the Firefly, as now in production in its Mk. 5 form, can be equipped as a night fighter or for anti-submarine work. The "A.S." variant carries special detection equipment under the wings and fuselage, in addition to the wing-mounted "radome" normal on all Fireflies, and has provision for sonobuoys. (Sonobuoys are dropped to enclose a suspected sea area, their under-water signals being reflected from a submarine hull and transmitted to the searching aircraft.) As a strike aircraft the

From top to bottom, the three British naval aircraft depicted below are the Westland Wyvern (Armstrong Siddeley Python turboprop), Fairey 17 (Armstrong Siddeley Double Mamba turboprop), and Blackburn Y.A.5. The Y.A.5 prototype has a Griffon piston engine, but the installation of a turboprop is foreseen.





Naval Strike and Anti-Submarine

type retains the four built-in 20 mm guns but can carry in addition, sixteen medium or eight heavy R.P.s; or bombs of various weights up to 1,000 lb (the maximum is 2 × 1,000 lb); or auxiliary tanks, which give a maximum range of about 1,400 miles. Tanks or bombs are slung on the same pick-ups and, extra to these, R.P.s can be carried as an overload.

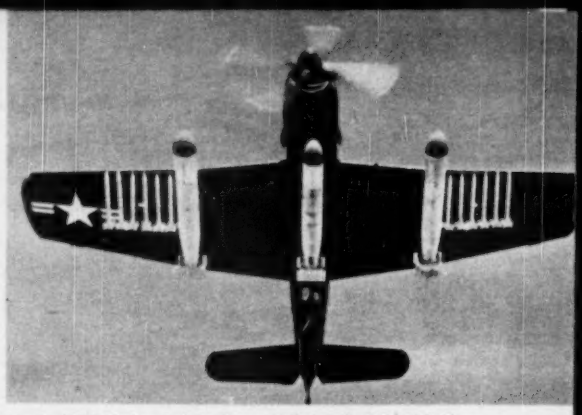
Among the world's largest and heaviest single-seaters, the Douglas AD-1 Skyraider and Martin AM-1 Mauler, as serving with the U.S. Navy, are notable for their impressive armament. Measuring 50ft in span and having a gross weight of over 16,000 lb, the Skyraider, in its present form, has a normal offensive load of 2,000 lb and a maximum of 6,000 lb. Two or three 2,000-lb bombs can be slung under the wings and fuselage as an alternative load to torpedoes or "Tiny Tim" R.P.s. (The "Tiny Tims" are of 11.57in calibre, 12ft long, weigh 1,173 lb, and have a penetrative power of 3ft of reinforced concrete.) Provision is made outboard for twelve 5in R.P.s. Two wing-mounted 20 mm guns are standard.

Development of the Skyraider is being actively pursued, and the AD-3 variant is powered with the Turbo-Cyclone 18 compounded engine. This model is adaptable for use as a dive-bomber, torpedo or rocket aircraft, for reconnaissance, radar counter-measures, "airborne early-warning," meteorological work and night bombing.

A much heavier machine, the Martin Mauler is roughly the same size as the Skyraider but is powered with the Pratt and Whitney Wasp Major engine of over 3,000 h.p. Carrying a war load of three 2,200-lb torpedoes, twelve 250-lb bombs and four 20 mm guns with 800 rounds of ammunition, a Mauler has been flown at a total weight of 29,330 lb.

Two variants of the Grumman Guardian, one for hunting and the other for attacking submarines, are on order.

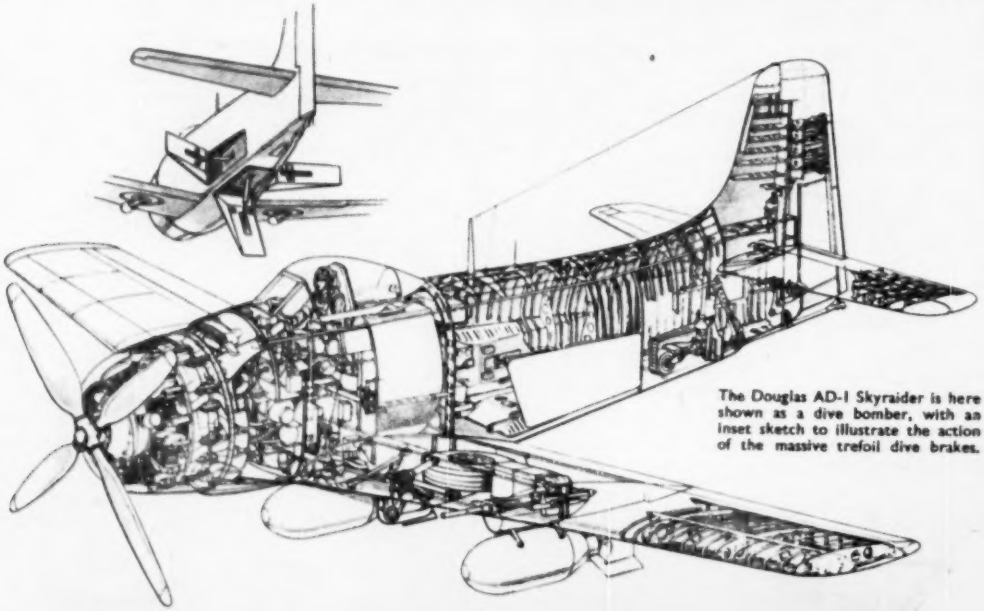
Of totally new concept in that, although designed to operate from a carrier, it has three power units (two Turbo-Cyclone compounded piston engines and one J-35 turbojet), the 55,000-lb, 420-m.p.h. North American AJ-1 has been designed to carry an atomic bomb. The crew of three is housed forward in a pressure cabin.



Martin AM-1 Mauler deck-landing attack aircraft of the U.S. Navy, carrying three torpedoes, twelve 5in R.P.s and four 20 mm guns.

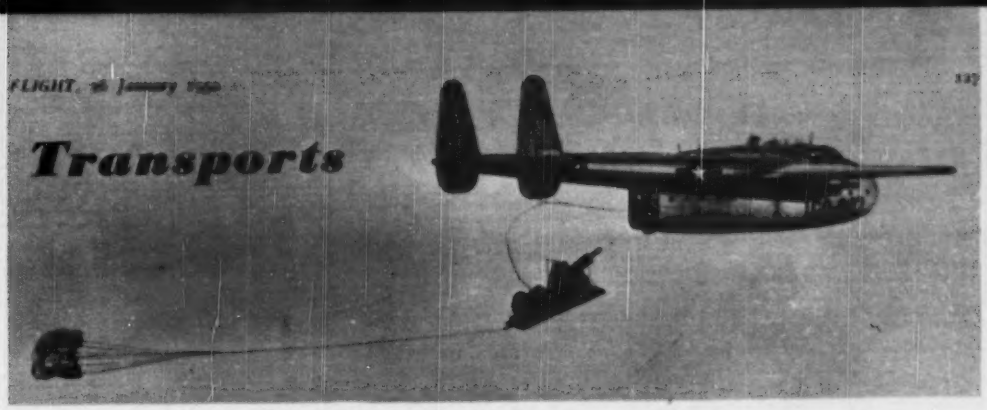
A special "electronic" variant of the Douglas AD-1 Skyraider, showing the massive plastic "blister" and modified tail unit.

North American XAJ-1 three-seater carrier-borne attack aircraft (two Pratt and Whitney piston engines and one J-35 turbojet).



The Douglas AD-1 Skyraider is here shown as a dive bomber, with an inset sketch to illustrate the action of the massive trefoil dive brakes.

Transports



A Fairchild C-82A Packet unships a field gun. This type is widely employed in U.S.A.F. transport squadrons.

CIVIL and military air-transport requirements are clearly defined, but a large measure of standardization appears feasible and, indeed, imperative. The U.S. Military Air Transport Service and, to a lesser degree, the R.A.F., are still operating a heterogeneous collection of wartime aircraft—a situation which, though it must be accepted for the present, must not obscure, as the Commander of M.A.T.S. has phrased it, "the inflexibility, inefficiency and extra expense which are unavoidable in such an assorted, non-standard fleet."

The Commander of the Combined Air Lift Task Force has publicly stated that untold numbers of men and great amounts of material and equipment could have been saved on the historic Berlin operation, and that there would have been fewer worries in air traffic control, had larger freight-hauling aircraft been available. No indication has been given of British intentions but certain basic characteristics have been recommended by the M.A.T.S. for a "strategic" transport aircraft. This must be a four-engined type, capable of carrying about 50,000 lb a distance equivalent to that between San Francisco and Hawaii (2,100 miles). Consistent with an overriding requirement for economy of operation, speed should be as high as possible, and the type should be capable of sustained operation at 25,000ft and of overflying all types of inclement weather. (This, of course, would demand pressurization.) Operation should be possible from any normal airfield with runways of 5,000-6,000ft and the fuselage should be sufficiently wide to permit "straightaway" loading and maximum utilization of the fuselage cross-section and overall tonnage capacity. There should be sufficient cargo doors to permit loading and unloading from normal M.T. vehicles without the use of auxiliary equipment such as fork lifts, and the fuselage must be designed for a cargo loading density of 8½-10 lb/cu ft up to a load of 50,000 lb. Strong emphasis is placed on interchangeability, simplicity and accessibility.

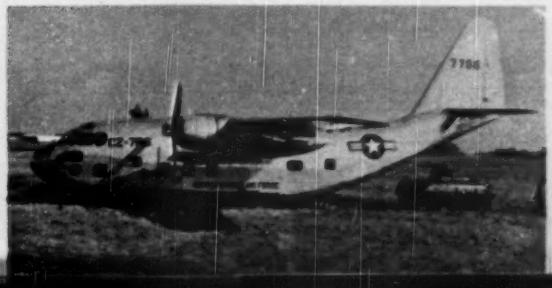
It is further laid down that the surface distribution of the aircraft in its contact with the ground should not be in excess of that of the Skymaster. Thermal de-icing is a requirement, and provision must be made for assisted take-off for use in emergency or when the aircraft is loaded to maximum gross weight. The fuselage heating system must be capable of maintaining an average internal temperature of 65 deg F at all times.

No reference, it will be noted, is made to the type of power plant in mind; here, however, is an obvious application for turboprop units, and it is not to be supposed that military authorities will spurn pure-jet propulsion should this afford the economies now envisaged in the civil field.

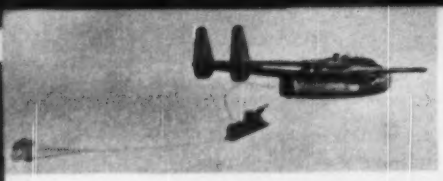
To illustrate the characteristics and capabilities of the newer equipment now in operation or under development

The three British transport aircraft depicted above are (top to bottom): the Bristol 170 (military version), Vickers-Armstrongs Valetta, and Blackburn and General Aircraft Universal Freighter.

Above is a Handley Page Hastings military transport (four Bristol Hercules engines), now the standard heavy transport aircraft of the R.A.F. Below is one of the U.S. Navy's Lockheed Constitutions.



Chase XC-123, with an armoured scout car about to enter the cargo compartment by way of the loading ramp. This aircraft weighs 24,790 lb empty and will carry up to 21,000 lb of cargo.



Transports . . .

reference will be made to representative types of transport aircraft. In succession to the Dakota, the R.A.F. has adopted the Vickers Valetta; the U.S.A.F. utilizes the Fairchild Packet, and the Soviet Air Force the Il-12. Whereas the Packet was designed specifically for military operation, with an eye to easy loading and unloading, the Valetta and Il-12 have been derived from civil designs. All three types are capable of transporting troops, freight or (excepting, perhaps, the Il-12) vehicles; of dropping paratroops and supplies, towing gliders and evacuating casualties. The Valetta will carry a maximum of 34 troops with 220 lb of equipment apiece, or, as a paratrooper, takes 20 men and six 350-lb containers. In the supply-dropping rôle twelve containers are accommodated, for which a roller conveyor and three despatchers are provided.

The C-119B version of the Packet has a designed gross weight of 74,000 lb. Of twin-boom layout, it has a very capacious central fuselage, the rear of which is split vertically so that each half can be hinged outwards to allow direct loading and unloading. A contract has been placed for an experimental development with a completely detachable fuselage suspended from a shallow nacelle and having a maximum load of 9 tons. With this development a special multi-wheel undercarriage is necessary. The ultimate intention is to arrange for the complete "pack" to be dropped in flight.

It is not, perhaps, generally known that the Bristol Type 170, now widely serving in a civil capacity, was originally envisaged as a military freighter. The present military variant of the type—notable for its nose loading doors—carries a wide diversity of loads, typical of which is one of 30 airborne troops, complete with equipment, in rearward-facing seats. Disembarkation is possible *via* the nose and rear doors simultaneously. Supply containers can be slung either on racks under the wings, or stacked inside the fuselage.

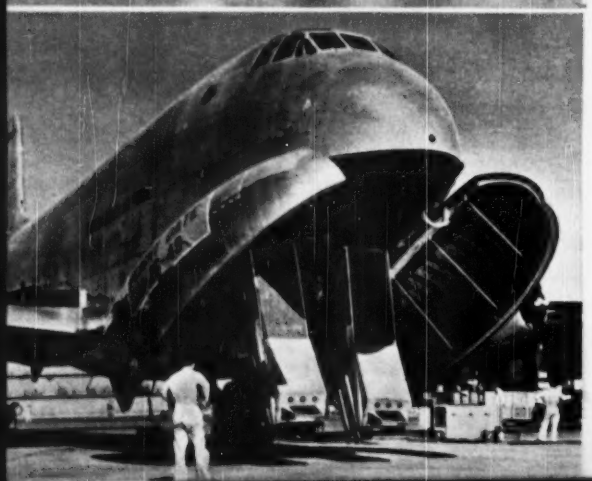
A large four-engined type, of later design than the widely used Skymaster, the Handley Page Hastings, now established in R.A.F. service, is a 75,000-lb machine, notable for its high performance (maximum speed 354 m.p.h.). Military equipment such as bulldozers, 25-pounder anti-tank guns and 3-ton lorries, up to a total weight of 7½ tons, are loaded with the aid of a specially constructed, air-transportable, ramp. A jeep and anti-tank gun can be slung on the underside of the fuselage and dropped, together with their crews, by parachute.

An especially interesting comparison with the Hastings is afforded by the 100,000-lb Blackburn and General Aircraft Universal Freighter which, though similarly powered, with four Bristol Hercules engines, is a machine of wholly different conception. Intended for relatively short-range operation, the Universal will be endowed with exceptional take-off and landing characteristics, rendering it capable of safe operation with full load from small airfields and landing strips, even under adverse atmospheric conditions. The general layout is evident in a photograph overleaf; total cargo space is 5,760 cu ft, and there is a hydraulically-operated built in loading ramp.

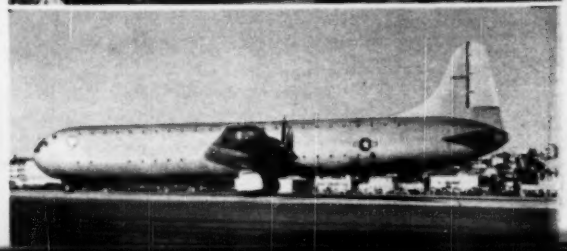
Economy and the ability to operate from confined spaces are likewise characteristic of two American types, classed by the U.S.A.F. as "assault" transports (indicating that the carriage of airborne assault troops will be a primary function) but much smaller than the Universal. These are the Northrop C-125 Raider and the Chase (Stroukoff) C-123 Avitruk. In the instance of the three-engined Raider, a weight of 29,400 lb is considered typical for take-off from undeveloped airfields or assault air heads, whereas 35,400 lb would be normal for an air head landing. The unstick run at the former figure is 275 yd.

A twin-engined type, the Avitruk will transport 60 troops or 50 litter patients; it is designed to carry a load well in excess of its own weight of 24,790 lb and is unusual in

Of the photographs below, the upper shows the Boeing C-97A (military Stratocruiser) and the lower, the nose of the Douglas C-124A.

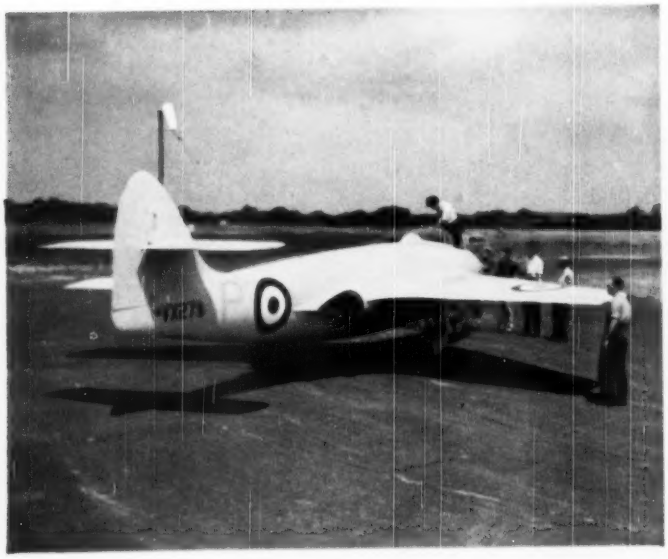


From top to bottom the military transports below are the Martin Mars, Northrop C-125 Skyraider and Consolidated-Vultee XC-99.



Flight, 28 January 1950

NAMES and NUMBERS . . .



THOUGH in the matter of aircraft nomenclature Britain is more fortunate than America, being less bedevilled by cabalistic numbers and symbols, the identity of some of our more spectacular military aircraft is nevertheless often concealed, from the layman at least, by mysterious numerals. Thus, "510" is the officially approved appellation of the swept-wing Vickers-Supermarine fighter in the large ground-study, while its Hawker counterpart, at lower left, is styled P.1052. But we British flatter ourselves that when a Service aircraft—production orders having been placed—does eventually receive a name, some apt choices are made. Was ever an aircraft more appropriately christened, for example than the Gloster Meteor, the Mk.7 trainer version of which is seen both inverted and on the climb, and was ever a finer compliment paid to a Commonwealth nation than in the naming of the English Electric Canberra, Britain's first jet bomber, seen at the head and foot of this page ? *"Flight" photographs by John Yoxall.*

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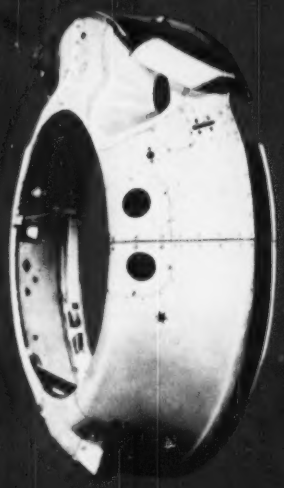
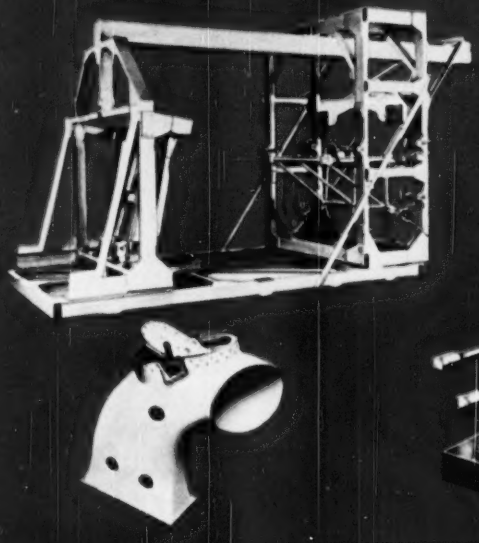
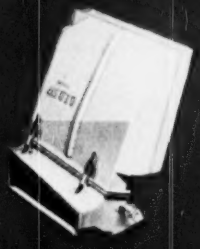
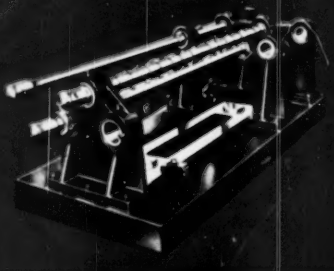
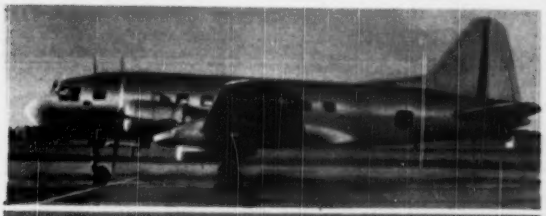


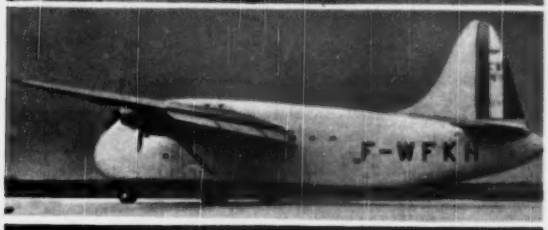


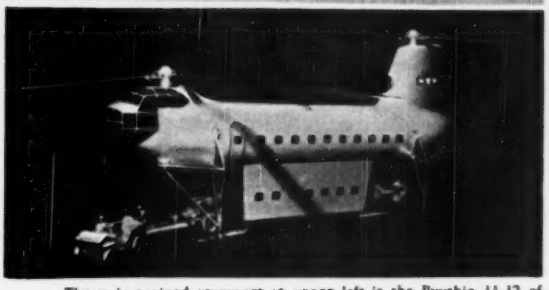


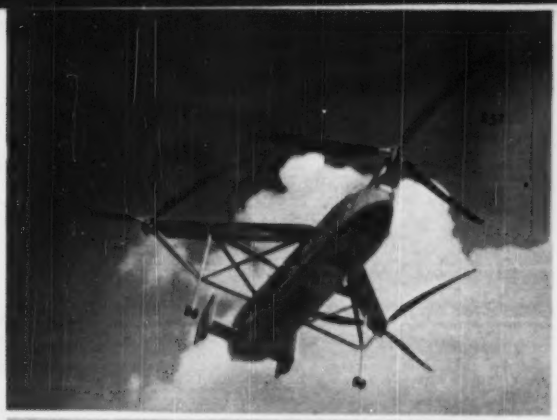


Transports..









The twin-engined transport at upper left is the Ilyushin 11-12 of the type used for the dropping of Russian paratroops. Below it is the French N.C. 211 Cormoran and a model of the projected Piasecki XH-16 helicopter, with a fuselage as large as the Skymaster's and a detachable, underslung compartment. On the right are the Cierva Air Horse, Piasecki HRP-2 and Sikorsky H-19.

having an undercarriage which retracts into the fuselage. A non-retractable, track-type gear, skis or floats are alternative installations.

Of the larger American "strategic" types, the Boeing C-97 family merits special consideration by virtue of high performance, great capacity and near relationship to the civil Stratocruiser. The latest C-97A carries up to 53,000 lb of cargo, or 134 troops with combat equipment; alternatively, as an ambulance, it accommodates 83 litter patients, four attendants and 2,800 lb of medical supplies. Under the tail is a ramp for the loading, to the upper deck, of vehicles or equipment. A specially developed delivery system permits the dropping of 25,500 lb of supplies through the rear hatch in under thirteen seconds.

A derivative of the Douglas C-74 Globemaster, operated over the Atlantic in support of the Berlin Air Lift, the new C-124 Globemaster II is designed to fly a load of about 50,000 lb for 850 miles, unload and return to base without refuelling. The fuselage provides more than 10,000 cu ft of usable cargo space, the cabin being nearly 13ft high and 77ft long. Clamshell nose doors and a built-in ramp facilitate loading. For troop transport the interior can be converted into a double-deck cabin with a capacity of 200 men with equipment.

Even more spacious is a projected development of the Convair XC-99, intended to lift 100,000-lb payload on the trans-Atlantic run, or 116,000 lb over shorter distances. Using major components of the B-36 bomber, it will have Pratt and Whitney Wasp Major engines and two decks, the upper pressurized for troops or hospital cases, and the lower—for cargo—unpressurized.

Though vulnerable to ground and air action, helicopters hold great promise not only as aerial cranes, or pantechnicons, but as weapons of assault, carrying shock troops with their specialized armament. Britain's 17,500 lb Cierva Air Horse, with a single Rolls-Royce Merlin engine, is the forerunner of a larger and much improved type, known as the W.11T, for which either two Merlins or two Dart turboprop units are foreseen. Designed gross and empty weights are, respectively, 15,350 lb and 9,650 lb, and the cabin volume 1,200 cu ft, as against the 800 cu ft of the Air Horse. Cruising at 128 m.p.h., a range of 440 miles should be attainable.

The Piasecki XH-16, being developed for the U.S. Navy, Army and Air Force, is forecast to attain the longest range ever achieved by a helicopter, and is notable for its exceptionally large dimensions. The fuselage will be of the same general shape and dimensions as that of the four-engined Douglas Skymaster and, additionally, provision is being made for a large, detachable, underslung pannier. Two types of undercarriage will be provided, the shorter for use with the normal fuselage only. With the taller gear the machine will be operated either with the pannier, or, without it, as a flying crane.

Another noteworthy American project is the Doman HC-3, transportable bodily by a Fairchild C-120 Packet and designed to carry a 6,600-lb load for 110 miles, or 1,300 lb for 1,400 miles. As a flying crane it could lift a 12,000-lb object for a short distance; troop capacity would be 33.

Interest in assault and cargo gliders is at a low ebb, development resources having largely been transferred to powered aircraft intended to meet similar requirements. In some instances, these themselves are closely related to gliders; the French Castel Mauboussin C.M.100, for instance, is a direct development of the unpowered C.M.10, now in limited production for the French Air Force.

Percival Prentices (D.H. Gipsy Queen engine) over the R.A.F. College.

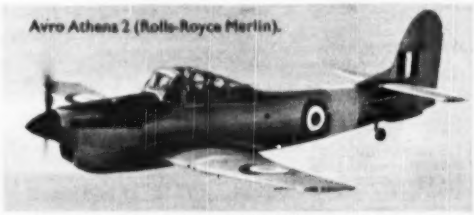
Trainers

Fokker S.14 (Derwent)

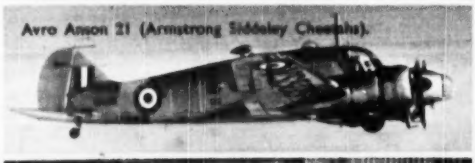
NO military aircraft have been subject to more indecision than trainers. Insofar as it has been formulated at all, future design and development policy is in many respects obscure; but a brief appreciation of the newest equipment and of discernible tendencies is possible, and the photographs herewith illustrate the diversity of designs now to be seen. Even this collection is restricted to types now in production, or under development.

Though in respect of performance and equipment trainer requirements vary radically, there are certain qualities which all classes—from the lightest "primary" to the fastest jet or heaviest crew trainer—must possess. Foremost among these are robustness and ease of maintenance, wide field of vision, sensitive and well harmonized controls, and viceless flying characteristics, particularly in regard to stalling and spinning.

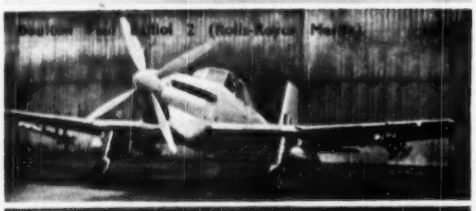
Though no primary trainer is now sponsored by the R.A.F. (excepting the D.H. Chipmunk, which is solely for Reserve use), a strong feeling persists that a light, low-powered aircraft with more sensitive controls than the general run of "basics" and "primary/basics", and generally more revealing of a pupil's probable ability as a pilot, should constitute the first rung of the pilot-training ladder. The Fairey Primer is a good example. It is, perhaps, signi-

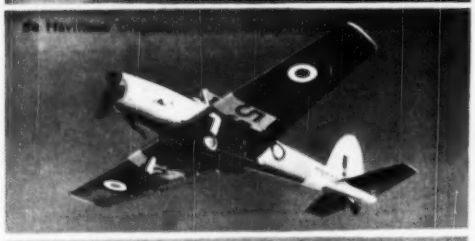


Avro Athena 2 (Rolls-Royce Merlin).

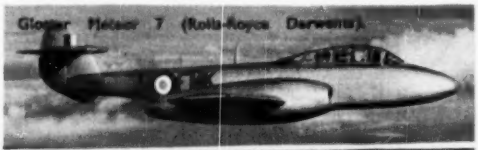


Avro Anson 21 (Armstrong Siddeley Cheetahs).

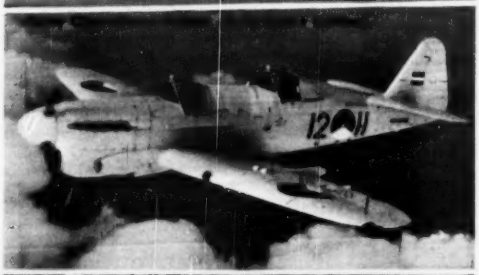




Fairey Primer (Gipsy Cirrus or Major).



Gloster Meteor 7 (Rolls-Royce Derwents).



Supermarine Spitfire Trainer (Rolls-Royce Merlin).

Vickers-Armstrongs Varsity (Bristol Hercules).

DEVELOPMENT

OF A THEME . . .

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Trainers . .

ficant that, having fostered the development of an 800 h.p. "primary/basic/advanced" trainer, the U.S. has seen fit to place an order for a quantity of undisguised "primaries," namely, Fairchild T-31s with 280 h.p. Lycoming radial.

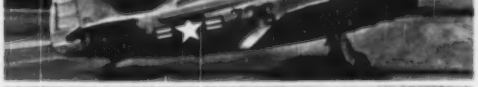
The standard basic trainer of the R.A.F. is the Percival Prentice, a 2/3-seater (pilot and pupil are side-by-side) designed to a 1943 specification and now well established in service. Its makers, together with Handley Page (Reading), Ltd., have lately been awarded contracts for the construction of prototypes intended for similar duties but powered with the Armstrong Siddeley Cheetah radial engine of 420 h.p. Some surprise—indeed, concern—has been expressed that a tail-wheel undercarriage should have been specified for these projects for, as will have been seen in the foregoing pages, the great majority of modern first-line aircraft have a nose-wheel. The Air Ministry, however, has weighed its decision carefully. In this connection, it is interesting to observe that, having regard to the nose-wheel *v.* tail-wheel controversy, Fokker have adopted the solution (being the first to do so) of offering their S.11 and S.12 2/3-seater primary trainers, one (the S.11) with "tail-down" undercarriage, and the other with a nose-wheel.

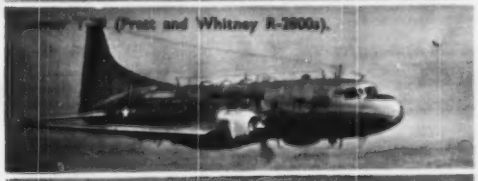
Two outstanding types of advanced trainer—the Avro Athena 2 and Boulton Paul Balliol 2—are at present undergoing official trials. Both are side-by-side two-seaters with a Rolls-Royce Merlin piston engine, and each has a Mk.1 counterpart fitted with an Armstrong Siddeley Mamba of Rolls-Royce Dart turboprop. Series production of these turbine versions is not at present contemplated. The Athena 2 and Balliol 2 have been designed not only for advanced flying training under visual and real or simulated instrument conditions, but for instruction in, and the practice of, navigation, dive bombing (with the use of dive brakes), gunnery, rocket firing and photography. They are suitable, moreover, for towing gliders or targets and the Balliol, which has folding wings, is adaptable for deck landing.

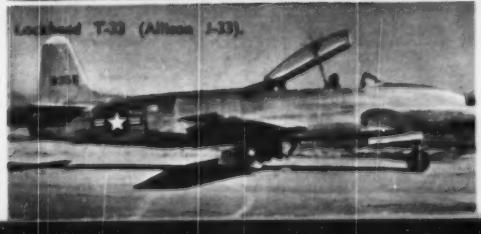
It is now R.A.F. practice to convert pilots under training direct from Harvards (for the replacement of which the Athena and Balliol have been developed) to Meteor 7 dual-control jet trainers. Possessing an even higher performance than the Meteor 4 fighter (especially in rate of climb, which is no less than 7,920 ft/min at sea level), the Meteor 7 was developed to familiarize pilots with the characteristics of 600-m.p.h. fighters and bombers and, in common with other jet aircraft, is generally conceded to be easier to handle than many piston-engined types. The front, or pupil's, cockpit has all instruments, warning devices, emergency and other equipment found in the standard fighter, but the instructor has only essential instruments and controls. No armament is fitted, but for instruction in combat procedure there is a camera gun and a retractable gyro gunsight.

Typical of high-performance trainers developed from first-line piston-engined fighters are the dual-control Hawker Fury and Sea Fury Trainers, the Supermarine Spitfire Trainer and the Fairey Operational Trainer—all having facilities for armament instruction. It will be recognized that in the adaptation of such aircraft the provision of an adequate field of view from the rear cockpit is a matter of difficulty, and some ingenious solutions have been applied to this problem by British designers.

Though their basic design is seventeen years old, the





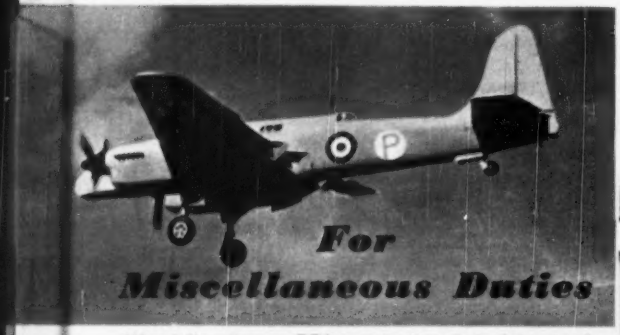


Trainers . .

latest Avro Anson twin-engined trainers in service concede little in efficiency to machines of much later date, and allow numerous variations of equipment. R.A.F. versions are laid out for navigational and radio training. A recently completed Dutch prototype, the Fokker S.13, though more powerful, is intended for similar duties. The roomy, high-wing Percival Prince, as adopted by the Royal Navy, is another thoroughly modern nose-wheel type for which the makers offer installations appropriate to bombing, free gunnery (Boulton Paul powered turret) and photography. Largest of all British trainers, the Vickers-Armstrongs Varsity, is best described as a crew trainer. This one aircraft, without conversion, affords facilities for training in navigation, bomb aiming, piloting, and the operation of the latest radio and radar gear. There is an underslung nacelle for the bombing instructor and his pupil. In many respects a counterpart of the Varsity, and likewise developed from an airliner, the American Convair T-29 can have separate seats, desks and radio and radar installations for sixteen pupils. Student navigators take celestial sights through four astrodomes.

A similar instance of parallel development is afforded by the jet-propelled Meteor 7, already mentioned, and the Lockheed T-33 (formerly TF-80C). Unlike the Meteor, the T-33 is pressurized, has ejector seats, two 0.5in guns and a remote hit recorder in the rear cockpit; like the Meteor it is suitable for the training of tactical reconnaissance pilots in the correction of artillery fire.

The first aircraft to be planned specifically with jet training in mind was the Nene-powered S.O.6000, now considered as a research aircraft and unlikely to pass into production. In common with this French type, the Dutch Fokker S.14, the prototype of which should take the air this summer, has side-by-side ejector seats. Here, however, the resemblance ends, for the Fokker should prove a much more docile instrument of instruction than the formidable, highly loaded French machine. The power unit of the S.14 is a Rolls-Royce Derwent with nose intake, and there are large fuselage-mounted dive-brakes.



For Miscellaneous Duties

(Above) Short Sturgeon T.T.2 target-towing and -simulating aircraft.

THE modern air force requires a diversity of second-line aircraft for vital (though, in some instances, uninspiring) tasks. Among these, target-towing, air/sea rescue and arctic rescue have greatly increased in importance during recent years. British target-towers are represented on this page by the Short Sturgeon, Fairey Firefly, and D.H. Mosquito (the Tempest and Beaufighter have been similarly adapted), while the Martin PBM-5A, also depicted, is an eminently suitable type for rescue, as well as for patrol. Vickers Supermarine Sea Otter amphibious biplanes and various Grumman types are also rendering excellent "A.S.R." service. Meteorological reconnaissance falls to the lot of adapted first-line types.

Helicopters are particularly valuable for "special" operations (e.g., secret service work, radar calibration and observation of torpedo trials), and for some of the more difficult rescue tasks. Together with fixed-wing A.O.P.s they serve admirably as communications aircraft, supported by such types as the de Havilland Devon (military version of the Dove), Avro XIX and larger V.I.P. transport machines, exemplified by the Vikings of the King's Flight.

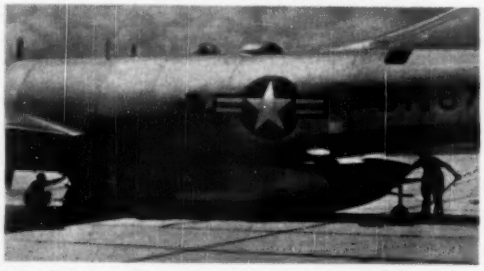
Mosquito T.T.39, adapted for target-towing.

Fairey Firefly target-tower, showing drogue winch.

Westland-Sikorsky S.51 general purpose helicopter

The Bristol 171 helicopter, suitable for a variety of tasks.

McDonnell XHJF-1 twin-rotor helicopter of the U.S. Navy.



U.S.A.F. airborne lifeboat being positioned under a B-29.

Martin PBM-5A—the world's largest amphibian.

This sister ship to ALUB, like all Marathons, "sits" well in the air and flies gracefully. Most good-lookers *are* good.

MARKETING THE MARATHON

Departure on a 35,000-Mile Tour to Australia and New Zealand

LAST week, the ceremony marking the departure of the Marathon I on its long sales and demonstration tour was recorded in *Flight*. The aircraft, G-ALUB, left Woodley on Saturday, January 14th, under the command of G/C. Bandidt, with Mr. Hugh Kendall as chief pilot, and is expected to reach New Zealand in fourteen days. The crew are seen in the accompanying photographs. Production of the forty Marathons ordered to date has commenced, and G-ALUB is standard in every way. It has its twenty seats packed inside, ready for fitting when the two 170-gallon long-range fuselage tanks, installed for the Tasman Sea crossing, have been removed. Nearly 2,000 lb of spares and luggage are also on board.

Horn balances are still fitted on this aircraft, but will be dispensed with later. The loop aerial is now mounted over the wing centre section. No deicing equipment is fitted at the present time, but a prototype Marathon will shortly carry out development tests with a thermal deicing system for early incorporation in production machines.

Noteworthy features of the Marathon freederliner, and ones which will interest airline passengers, are the very roomy cabin with large windows providing an excellent view of the country below, its low, horizontal floor making for easy entry and exit, and its four-engine safety. It meets full I.C.A.O. requirements. Pilots will approve the pleasant flying characteristics and a roomy cockpit with excellent all-round view.

Summarized data concerning the aircraft and its demonstration tour are as follows:—

Aircraft: Span 65ft; wing area 498 sq. ft; length 52ft 1¼in; height 14ft 1in; cabin width, length and height, 7ft 6in, 18ft, 6ft 3in; seating for 18, 20 or 22 with toilet; weight empty 12,000 lb; max a.u.w. 18,000 lb. **Engines:** 345 b.h.p. Gipsy Queen 70s. Cruising speed 160/210 m.p.h.; max. speed 232.5 m.p.h.; max. w.m. range 850 miles.

Suppliers especially concerned with demonstration tour include: The de Havilland Engine Co.; Marconi's Wireless Telegraph Co., Ltd. (radio compass 7092); R.F.D., Co., Ltd. (dinghy and rescue equipment); L. A. Rumbold and Co., Ltd. (seats); Standard Telephones and Cables, Ltd. (S.T.R. 11, 12 and 13 radio); Ultra Electric, Ltd. (inter-com.).

Route out: Rome, Athens, Nicosia, Baghdad, Bahrain, Karachi, Delhi, Calcutta, Bangkok, Singapore, Sourabaya, Darwin, Cloncurry, Charleville, Sydney and Norfolk Island. **Route home:** Koepang, Bali, Sourabaya, Batavia, Singapore, Penang, Mergui, Rangoon, Calcutta, Vizagapatam, Hyderabad, Bombay, Karachi, Jiwani, Sharjah, Basra, Teheran, Baghdad, Damascus, Cairo, El Adem, Castel Benito, Algiers, Madrid and Bordeaux.

(The illustrations in the adjacent column are from "Flight" photographs)

After careful preparation, fitting of extra fuselage tanks and the packing-in of spares, the Marathon is ready for its long journey.

Before take-off from Woodley. (*Flight*'s Gemini in foreground.)

The crew, together with Mr. Gray (hand in pocket), Sir Frederick Handley Page, and, on his left, Mr. Lennox. (Below). A farewell message is recorded in the presence of Mr. Peter Masefield.

A Canadair DC-4M2 North Star (Four Rolls-Royce Merlins) of the T.C.A. fleet. The city spread out below is Verdun, Quebec.

ACROSS CANADA

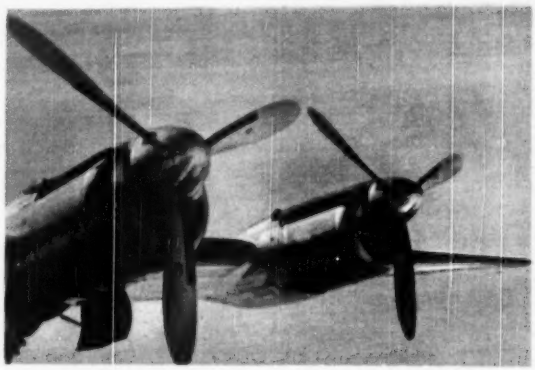
—by Canadair : What the T.C.A. Passenger Sees

A FEW weeks ago I made my first long flight by Trans-Canada Air Lines since the company introduced its Canadair Fours. The journey from New York to Toronto, and subsequently across the country to Vancouver, brought back many memories of Service flying. Time seems to grow shorter in retrospect, so that the prairie landscapes made it seem only yesterday that one spent many happy hours of instructing in those skies; and the voices of the four Merlins, particularly when taking-off, raised a nostalgic lump in the throat, for they sounded exactly like those on a Lancaster—and what more deeply moving experience than to witness or participate in the take-off of a squadron of heavily loaded Lancs on a night raid? The long trans-Canadian journey itself now seems to have occupied no more than an hour or two, although in truth it took from early morning until late evening, in spite of advantageous time-changes, to cross Manitoba, Saskatchewan, Alberta and B.C.

Although it is difficult to enter the United States, there seems to be no objection to one's leaving. I presented myself at the internal or domestic side of La Guardia airport, and was led by a coloured porter (Red Cap, Blue Cap, Speed Cap, or some such name) to the T.C.A. departure gate at the farthest end of the buildings. My ticket, purchased some time before in England, was endorsed, and within a few minutes all passengers (about two-thirds of the aircraft's maximum capacity) were called on to embark. Never was there less fuss or formality.

The route to Toronto takes one over some beautiful country which soft winter hues enhance. Nearing Toronto one may gain a glimpse of Niagara Falls, or if not of the Falls proper, of the river at its two widely different levels.

Except in the matter of silence, Canadairs are comfortable in a neat and plain way. The inboard Merlins are equipped with short, cranked exhaust pipes, terminating in a fishtail device. Outboard banks and outboard engines have stub outlets. The take-off seemed quite leisurely, but once airborne the machine seemed to climb and get a move on in a businesslike manner.



Inboard banks of the Merlins carry exhaust pipes and fishtails.

Attractive, with an American flavour : a T.C.A. Skyliner at Dorval.

(Below) T.C.A. freight handling is efficient : a conveyer in operation.

DRAMATIC PERFORMANCE

S.B.A.C. Display *Farnborough, 1949.*

"The Avon-Meteor with its phenomenally fast climb of 40,000 feet in a fraction over 4 minutes, showed off another remarkable virtue of the Avon. Returning from one of his sweeping climbs, the pilot shut off both engines and trailed two plumes of unburned kerosene as he dived towards the airfield. With the plumes still breaking from the jet nozzles he flattened out, then climbed again, rolling as he went. Just as it seemed that he must stall and fall towards the earth the plumes vanished abruptly and simultaneously, and the Meteor continued its climb. The pilot had demonstrated with an excusable touch of drama how instantly the Avons relight in mid-air."

"AIRCRAFT & AIRPORT"

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The world's most modern air cooled radial engine in the medium power class

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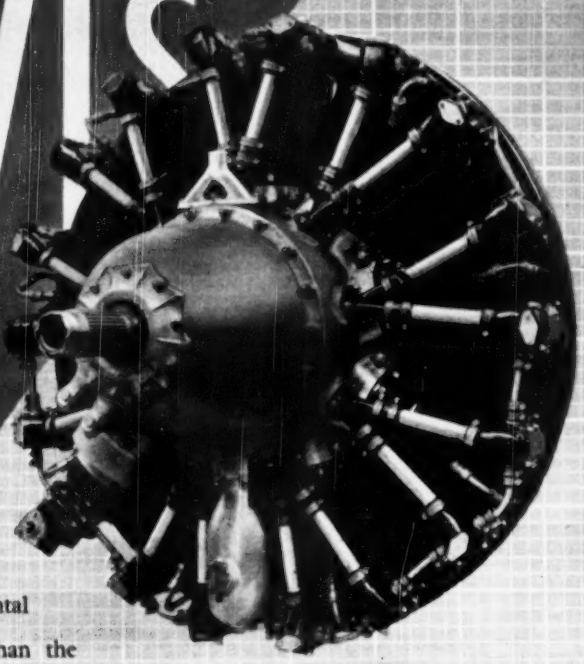

It has nine cylinders for smooth running, with 24 per cent. less frontal area and lower weight per B.H.P. than the nearest comparable type. It develops 550 B.H.P., has an anti-icing fuel-injection system and automatic mixture and boost controls. The fuel and oil systems are unaffected by negative G. These are a few of the unique features of the

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ACROSS CANADA . . .

Seating is comfortable, and there is something refreshing about the clean white anti-macassars on the seat headrests. An amidships galley and coat locker divide the accommodation into two cabins. That at the rear is the smaller, but quieter. Toilet compartments are placed forward and in the tail.

Refreshments were served on this first leg of the flight and, in minutes it seemed, we stepped out at the smart modern airport of Malton, home of the Avro Canada Company.

Later sections of the flight west took a now-full Canadair on to Winnipeg, Saskatoon, Edmonton, Calgary and finally Vancouver. In many places the wartime control buildings have been converted for civil use, and bright and comfortable for the brief calls they proved to be. No sooner had the four Merlins stopped turning than vehicles converged on the aircraft in an orderly, pre-determined manner, and commenced to refuel, remove luggage and mail, and load more meals for the passengers. As a result, the aircraft was ready to take off again in the shortest possible time.

The first hundreds of miles from Toronto take one over some barren, rocky country with stunted evergreens and innumerable lakes, large and small. By the time Winnipeg is reached the vast plain stretches in every direction as far as the eye can see in the clear atmosphere. Saskatoon is prairie country, flat also except for small ravines, mostly dry, cut by snow water in the spring. Trees are very few, and the continuity of the winding single railway lines is broken only by the grain elevators which are always a feature of the prairies. So much country, part cultivated, but divided everywhere into equal sections, and with mile upon mile of straight mud road, intersecting always at right-angles, engenders mixed feelings of wonder and monotony.

Frequent meals or light refreshment and a selection of magazines keep boredom away, and during this particular ride I amused myself (until capacity put a stop to it) by trying to get a glass of milk from the stewardess without the inevitable two biscuits. Apparently they follow each other as the night the day.

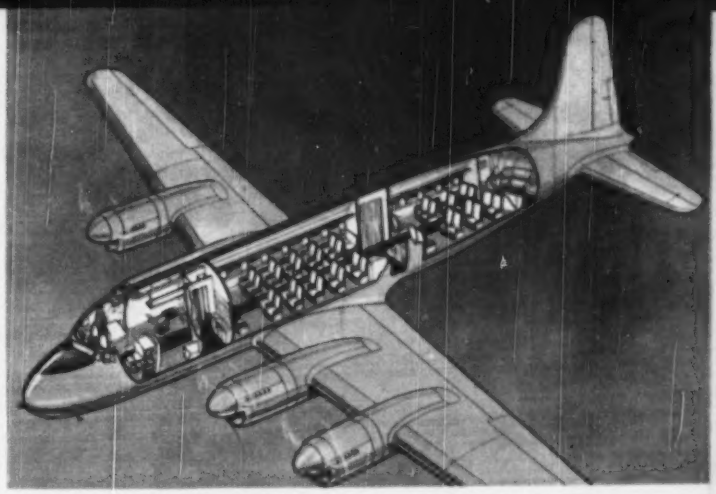
When dusk was near we approached Edmonton over low, unbroken stratus, and to my great regret the mighty ranges of the Rocky Mountains farther west were obscured by cloud. The pilot, using a procedure let-down, made a pass at the airfield but was compelled at about one hundred feet to pull up again and proceed to Calgary, his alternative. Passengers bound for Edmonton appeared to contemplate their long night-train journey back with complete resignation.

As we flew south there were occasional views of towns, lakes and airfields, the evocative names of which will bring back divers memories to hundreds of aircrew trained under the Commonwealth plan—Wetaskiwin, Ponoka, Sylvan Lake, Red Deer, Penhold, Innisfail, Bowden and Olds.

At Calgary I stepped out into a cool, wet evening at the one-time R.A.F. airfield of No. 37 S.F.T.S. A sensible traveller would have broken his journey here to spend an evening in one of the comfortable hotels in this fine little city and to make sure of a flight in daylight over the Rockies. Unfortunately, this could not be considered on a business trip, and on and up into the night sky we flew, completing the 400 or so miles to Vancouver in cloud or between layers. There was some reward at the end of the night journey, for despite cloud and rain the bright multi-coloured lights of the city and shipping, visible as we circled the airport, made an entrancing spectacle.

In conclusion, a reminder of Canadair data will be of interest: Span, 117ft 6in; length, 93ft 5in; height, 27ft 7in; weight empty, 48,000 lb; all-up weight, 80,200 lb; cargo capacity, 7,500 lb; fuel capacity, 3,300 gall; range, 3,800 miles; max. cruising speed, 306 m.p.h.

M. A. S.



Interior layout of the 40-seat North Star. Between cabins are the main entry, galley, wardrobe and crew seat for two, whilst forward (men) and rear, are spacious toilet compartments. A starboard door opens into the cockpit.

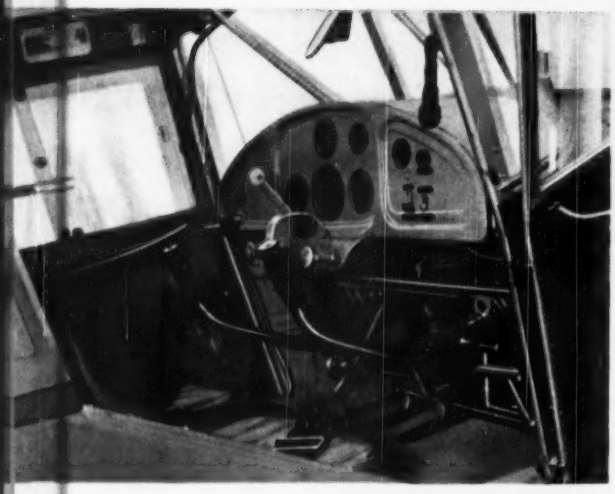
At Malton: the North Star in which the trip was made.

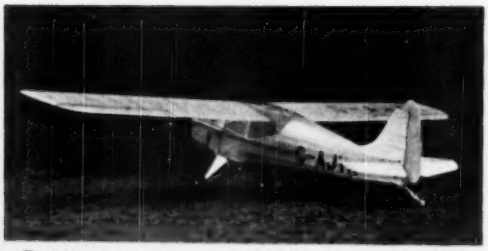
Servicing vehicles, duties completed, make way for passengers.

(Below) Plain but bright and spacious—a DC-4/2 cabin.

Illustrated with "Flight" Photographs

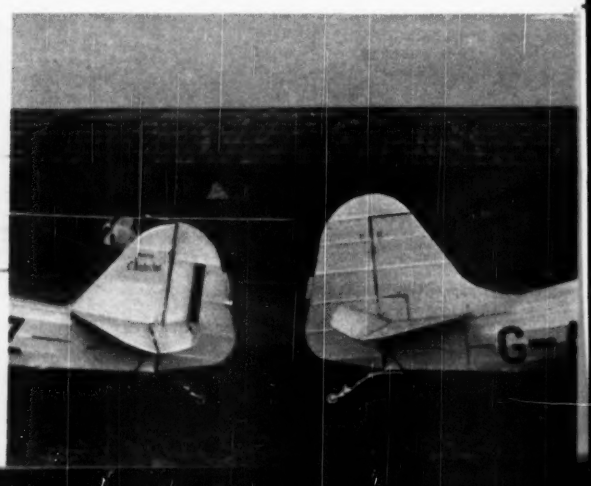
PRACTICAL FOUR-SEATER





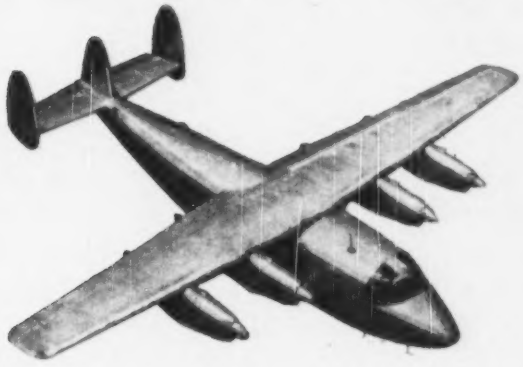
ONE of very few new British light aircraft, the Auster Autocar with de Havilland Gipsy Major I engine represents a very creditable attempt to meet the requirements of the private owner in the rather artificial conditions of to-day. It has been designed with very low maintenance costs in mind; the simple fabric-covered tubular construction and, in particular, the Gipsy Major I engine with an overhaul period of 1,500 hours, contribute to the achievement of this object. An additional talking-point is the provision of four seats, dual control, and all essential equipment for the competitive price of £1,500. The Autocar has recently been making first demonstration flights in Belgium and Holland.

INTENDED, as the name implies, to serve as a car of the air, the Auster Autocar cruises at 106 m.p.h. for a fuel consumption of 6½ g.p.h. Total fuel capacity is 32 gallons. The wing resembles that of the three-seat Autocrat—36ft span, 185 sq ft gross area—but the tail is larger, as may be seen in the comparative views below (Autocar on right). The controls and instruments, including individual heel-brakes, follow Auster practice, but the rear fuselage is 8in wider than on previous models. The two doors give access to all four seats, the backs of the front seats folding flat. It will be noticed that a Fairey metal airscrew is fitted, and also a silencer.



HASTINGS

Versatility



MARATHON

Service aircraft by Handley Page are renowned for their robustness and versatility . . . . . their vocation is the handling of military transport's multifarious tasks in any climatic condition throughout the world . . . . . freighting, paratrooping, supplies-dropping, glider-towing and communications are their everyday concern . . . . . maids-of-all-work, they yet have that extra stamina which carries them in triumph through any emergency.

HASTINGS, the standard, long-range, transport of the R.A.F., more than proved its worth on the Berlin air-lift . . . . . it carried cumbersome, high-density loads which could be handled by no other aircraft . . . . . with a top speed of 347 m.p.h., it has a range of nearly 4,000 miles, payload of 10 tons and 3,000 cu. ft. of cargo space . . . . . it will tow the largest glider, carry 60 casualties as a high-speed ambulance and drop jeeps, guns and ammunition by parachute.

MARATHON is a dual-purpose, small, four-engined transport whose high performance exceeds the most exacting safety requirements . . . . . military applications embrace flying-classroom and light freighter duties . . . . . as V.I.P. communications aircraft, its four-engined safety factor is of special significance . . . . . it carries 22 passengers or nearly 2 tons of freight over 500-mile stage distances at a maximum cruising speed of 210 m.p.h.

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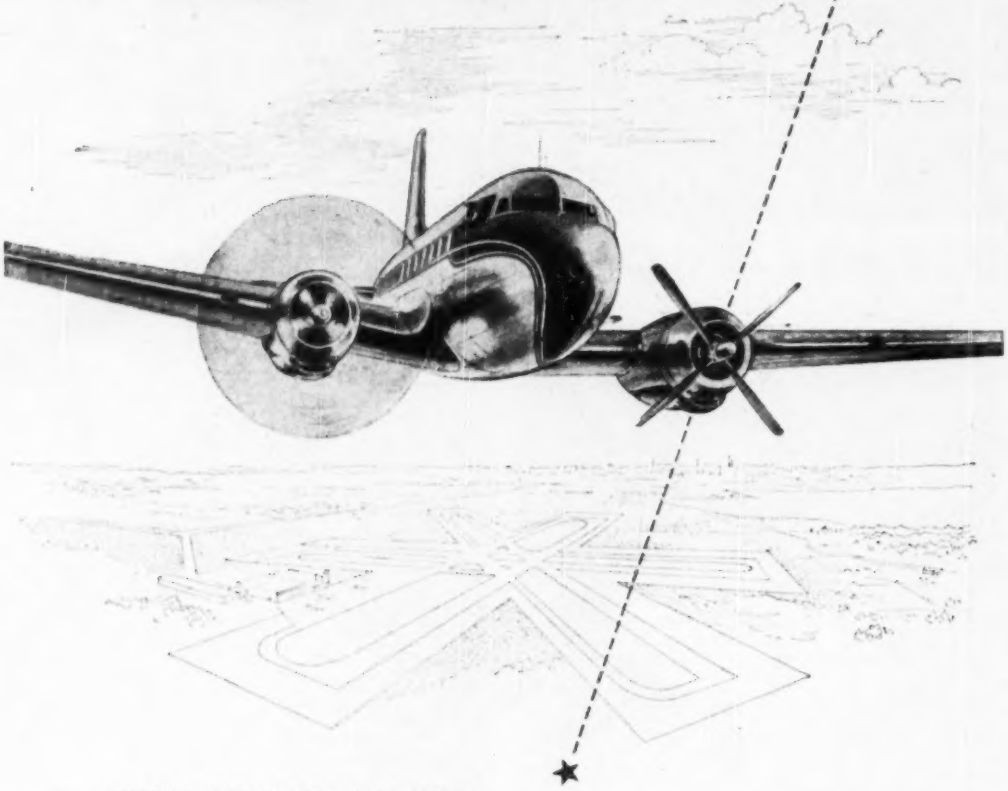

SINGLE ENGINE PERFORMANCE

Service Ceiling, Max. Continuous Power, Weight 33,500 lbs. . 11,150 ft
($R/c = 0.02 \cdot V_{so^2}$ ft/min)

Rate of Climb, Max. Continuous Power, Weight 33,500 lbs
Sea Level. . . . . 860 ft/min
5,000 ft Altitude. . . . . 300 ft/min

Min. Runway Length, required by CAR
Take-off, Sea Level, Weight 35,000 lbs. . . . . 3,986 ft
Landing, Sea Level, Weight 31,400 lbs. . . . . 3,180 ft

Even if one engine becomes inoperative, the Scandia's stability and manœuvrability remain unimpaired. In fact the plane's single engine performance puts it in a class by itself. All pilots who have flown the Scandia are unanimous in praise of its remarkable flight characteristics.

Scandia

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CIVIL AVIATION NEWS

ICE-APPROVED : As reported on this page, the Vickers Viscount (the "700" production version of which has been ordered by B.E.A. and B.O.A.C.) has successfully concluded icing trials over the Atlantic. Delivery of the first "700s" to the Corporations is expected in 1952.

The Instrument Rating

AN official announcement which should gratify the pilots and companies affected concerns postponement of the date from which the holding of an Instrument Rating will be compulsory for all pilots flying in controlled areas in I.F.R. conditions. M.C.A. *Information Circular* No. 18, dated January 18th, states that "a review of progress in the issue of Instrument Ratings has led to the conclusion that adherence to the date April 1st might entail considerable curtailment in commercial air services. . . . It has accordingly been decided to amend the date specified in Rule 28 (2) of Schedule II of the Air Navigation Order, 1949, to October 1st, 1950. The period within which pilots' "B" licences may continue to be renewed will also be extended to October 1st.

The introduction of the Instrument Rating will, however, result in the desired all-round improvement in safety only when a similar standard is enforced by all foreign operators.

In an attempt to co-ordinate traffic control and navigational facilities, and with particular regard to the urgency of such a need in the European area, meetings of airline authorities, sponsored by I.A.T.A. are now in progress.

Airport Health Regulations

PASSENGER handling at many European airports will be facilitated by an agreement, concluded between the countries of Western union, to simplify air travel health control. With effect from February 1st, Belgium, France, Luxembourg, the Netherlands and the United Kingdom will become a single area and will be treated administratively within the Brussels Treaty powers as an "excepted area" in the matter of such control.

Any aircraft starting its flight at any point within this area will not in normal circumstances be subject to health control on its arrival at any other point in the area. The "aircraft declaration of health" and "personal declarations of origin and health," both time-consuming factors in traffic handling, will thus be unnecessary for such flights. An aircraft entering the "excepted area" from outside will now be subjected to health control only at the first touching-down point. This greatly simplified procedure will not, it is thought, in any way impair the efficiency of the health-control system in general.

Radio Industry's Views

SPEAKING at the annual luncheon of the Radio Communication and Electronic Engineering Association in London last Friday, Mr. F. S. Mockford, the chairman, expressed concern "at the absence of the British Commonwealth equivalent to the U.S. plan for a co-ordinated airways radio system.

"During the enquiry into the serious air accident at Prestwick," he said, "it was officially stated that recording devices, which would have considerably helped the work of the Court, were not in existence. This gave rise to totally erroneous statements about the necessity for spending dollars. If the Association had been approached, there can be no doubt that very real help in obtaining British equipment to the Ministry's requirements could have been given.

"Since 1946, industry has been handicapped in the development of radio systems for the airways due, first, to the difficulties in reconciling conflicting views on world requirements and, secondly, to the great expense involved in building up from its own resources a co-ordinated system for what, after all, is a limited market.

"The Association has placed these considerations before the Civil Aviation Radio Advisory Committee with certain suggestions as to how the difficulties might be met.

"The case put forward by the Association has, so far, received favourable consideration and the discussions are still in progress.

"During the year the air transport corporations have shown a welcome interest in British manufactured air radio equipment and their new fleets will carry British equipment."

Mr. Mockford added that there was no doubt that a considerable saving in dollar expenditure on radio could have been effected if British equipment had been ordered by B.O.A.C. for some of their American aircraft. Had the necessary stimulus been applied, as it was in the case of the Canadian aircraft, he had no doubt that the radio industry would have responded.

The American plan to which Mr. Mockford refers is presumably that contained in the report of the special Air Traffic Control Sub-Committee (S.C. 31) of the Radio Technical Commission on Aeronautics. The report recommends development and re-organization of traffic control and navigational systems to the extent of $1,113,000,000. Adoption of a comparable plan by the British Commonwealth would, of course, have to take into account the fact that traffic densities on most British routes do not approach those of America's internal airways.

AUSTRALIAN EXPERIMENT

THE Australian Department of Civil Aviation has obtained a cross-wind landing gear which will be fitted to a DC-3 for extensive experimental trials. Tests to determine its efficiency are being carried out with a view to economy in the construction of airports throughout Australia. The present plan envisages the provision, in addition to the major airports at capital cities, of 70 country airports with two or three runways each and ten further two-runway airfields in New Guinea. Runways for inland towns are said to cost £8,000 each, for New Guinea £120,000, for capital cities £200,000 and for international airports £500,000. These figures suggest that if, as a result of the trials, cross-wind landing gears are adopted, very considerable economies will be possible. Single-runway airfields would reduce the amount of land required and thus enable the airports to be constructed considerably nearer centres of population.

VISCOUNT DE-ICING TRIALS

THE prototype Vickers Viscount recently completed a series of flight trials under severe icing conditions off the coast of Ireland. The tests, which took place at between 5,000 and 10,000ft, were intended to prove that the aircraft's flying characteristics would be satisfactory in icing conditions, that the thermal de-icing system would remove accumulated ice and, furthermore, that the system would prevent ice from forming. The equipment employs a mixture of cold air from the scoops of the nacelles and gas from the exhaust of the Darts.

During the three days on which the aircraft was flown from Shannon, a total of ten hours' flying over the Atlantic was

CIVIL AVIATION NEWS . . .

recorded. The trials, it is stated, proved that the aircraft could successfully fulfil all three requirements.

The Viscount prototype has now completed a series of night and pressurization trials totalling 400 flying hours. The Viscount 700, a development of the prototype, is expected to be flying this summer. It has been ordered by B.E.A. for use on Continental routes and by B.O.A.C. for use on the Caribbean services of British West Indian Airways.

GREEK AGREEMENT

AN air route re-allocation agreement was recently signed by T.A.E. and Hellas, the two principal Greek airlines. It is designed to end the wasteful over-capacity, caused through the duplication of routes, which has existed since the inauguration of Hellas services early in 1948. As a result of the new agreement, T.A.E. will remain the main internal carrier and Hellas the principal international operator. The division is not absolute, however, as Hellas will retain a small number of national routes and, likewise, T.A.E. will keep a small number of international routes.

The agreement also provides for co-ordinated expansion of capacity by balanced aircraft purchases and for the implementation of a standard I.A.T.A. inter-line ticket agreement. This very significant accord will undoubtedly ensure increased load-factors and improve operating economy, thus permitting the Greek air-transport industry to recover from its present penurious condition.

CHANNEL CAR-FERRY

THE Ministry of Civil Aviation has granted permission to Silver City Airways to operate the Lympne to Le Touquet car-ferry service (under an associate agreement with B.E.A.) for a further period of two years. The company is planning to use additional aircraft this year and to carry at least 6,000 vehicles as compared with 2,700 in the 1949 season.

No concession has been made regarding the reduction of landing fees which, at the English terminal, are considered very high in relation to the shortness of the journey; consequently, fares are unlikely to be decreased. Additional passenger and Customs facilities are being built at both terminal points and it is expected that as many as 24 services a day will be operated during the peak periods. Bookings have already been received for many months ahead, and traffic at Easter—coinciding as it does with the re-opening of the Le Touquet Casino—is likely to be very heavy.

U.K. AIRPORT TRAFFIC

AIRCRAFT movements reported at civil airfields in the United Kingdom during August, 1949, and recently published by M.C.A., totalled 63,000, of which 25,000 were transport flights. London and Northolt together handled 44 per cent of the passenger total. Holiday traffic at Ronaldsway, Isle of Man, made it the third busiest airport with 23,000 passenger and 2,400 aircraft movements. Details are given below.

Airfield	Aircraft Movements			Passengers (terminal and transit)	Freight (lb)
	Air Transport	Other Flights	Total		
Aberdeen (Dyce)	278	321	599	2,302	21,017
Belfast (Nutts Corner)	862	96	958	18,691	82,893
Birmingham (Elmdon)	473	2,432	2,905	3,533	14,572
Blackbushe	208	717	925	2,921	371,500
Blackpool (Squires Gate)	839	6,938	7,777	3,119	69,094
Bovingdon	216	1,754	1,970	3,117	364,460
Bristol (Whitchurch)	140	1,032	1,172	280	—
Cardiff (Pengam Moors)	700	3,063	3,763	3,190	55
Croydon	1,265	1,372	2,637	5,164	159,351
Edinburgh (Turnhouse)	215	526	741	3,323	1,264
Gatwick	221	912	1,133	1,773	526
Glasgow (Renfrew)	1,617	366	1,983	21,050	65,865
Hurn	54	2,569	2,623	231	—
Inverness (Dalcross)	330	78	408	3,592	9,889
Isle of Man (Ronaldsway)	2,421	342	2,763	22,955	120,843
Kirkwall	424	41	465	3,425	16,926
Leeds (Yeadon)	137	950	1,087	1,342	584
Liverpool (Speke)	902	769	1,671	14,568	81,361
London	2,527	1,602	4,129	45,559	1,336,388
Lympne	741	1,751	2,492	3,158	2,600,296
Manchester (Ringway)	1,277	1,476	2,753	17,090	155,130
Northolt	4,709	1,342	6,051	88,725	916,257
Nottingham (Tollerton)	94	1,039	1,133	423	—
Prestwick	920	964	1,884	14,013	38,180
Shoreham	83	1,794	1,877	219	—
Southampton (Eastleigh)	1,108	1,840	2,948	8,476	5,658
Southampton Water	103	420	523	2,183	56,457
Weston-super-Mare	379	1,688	2,067	2,003	—
Wick	326	18	344	805	970
Other Aerodromes	1,436	557	1,993	7,838	72,226
All Reporting Airfields	25,205	38,769	63,974	305,068	6,562,792

BREVITIES

ELEVEN Plymouth flying-boats now available for disposal by B.O.A.C. will continue to be offered for sale until the end of this month. If no offers have been received by that time, states the Corporation, the high cost of maintenance will make it necessary to break them up.

* * *

The M.C.A. announces the appointment of Northolt's commandant, A.V.M. S. P. Simpson, C.B., C.B.E., M.C., as Divisional Controller of the London and South Eastern Division. He will succeed A.V.M. Sir Charles Roderick Carr, K.B.E., D.F.C., A.F.C., whose contract of service expires on January 31st.

* * *

As a result of the recently concluded Australia-Ceylon air agreement, Air Ceylon International made its first scheduled flight from London to Sydney on January 20th *via* Rome, Cairo, Karachi, Bombay, Colombo, Singapore and Darwin. The inaugural service from Australia will leave Sydney on January 29th. Air Ceylon International is managed and operated by Australian National Airways (Pty.) Ltd.

* * *

Swissair is to resume its regular transatlantic services between Zurich/Geneva and New York, via Shannon and Gander, from February 24th; frequencies on this route were reduced during the winter months. There will be one weekly flight in each direction until March 27th, when the frequency will be increased to two eastbound and two westbound flights per week.

* * *

L.A.I., the Italian airline, is claimed to be the seventeenth major concern to select the Douglas DC-6 for service on its routes. It is expected that the New York-Rome DC-6 service will be established in time for the heavy traffic anticipated during the Holy Year celebrations.

The total capital investment made by the Australian Government towards the development of civil aviation had reached £A11,000,000 at the end of the last financial year.

* * *

According to final estimates for 1949, United Airlines carried 2,200,000 passengers and flew some 1,340,000,000 revenue passenger-miles. Compared with 1948, the totals represent a 13 per cent increase in passengers carried and a 10 per cent increase in passenger-miles flown. The company also flew 23,700,000 freight ton-miles, 11,170,000 mail ton-miles and 6,738,000 express ton-miles.

* * *

The Piaggio Company of Genoa announces that its P-136 five-seater amphibian is now ready for distribution. The aircraft is powered by two Franklin engines and carries a useful load of 1,750 lb.

* * *

Alderman R. G. Robinson, J.P., of Cardiff, and Mr. Robert Hudson, of Swansea, have accepted invitations from B.E.A. to fill vacancies on the Welsh Advisory Council for Civil Aviation, caused by the death of Alderman Purnell and the resignation of Mr. J. B. Bennett.

* * *

On January 21st Air India International inaugurated its second long-distance international route. The new service links Bombay with Aden and Nairobi and is flown by the company's *Princess*-class Constellations. Frequencies are fortnightly and the elapsed time from Bombay to Nairobi is 14½ hours.

* * *

Traffic statistics for 1949 show considerable increases on all the Air France services from London to points in Europe, with the exception of Switzerland. On the London-Paris service the number of passengers carried increased by 40 per cent. An average of 125 passengers per day were flown between France

WORLD-WIDE CONFIDENCE.

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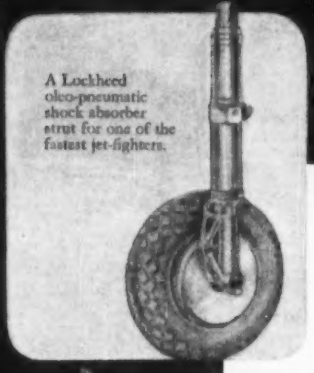

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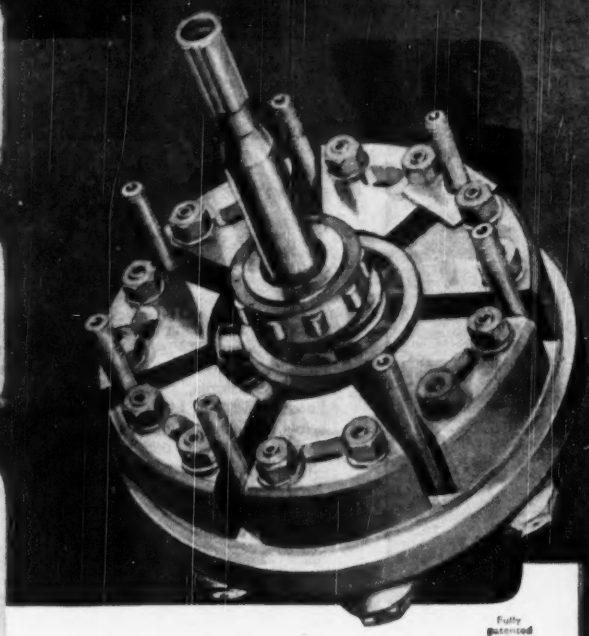
A Lockheed articulated undercarriage with Lockheed oleo-pneumatic struts.



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Among these is the high-precision pump, shown above, which delivers 2½ g.p.m. at 3000 p.s.i. at 3000 r.p.m.: 36,000 of these have been supplied. The Servodyne system, which gives positive and immediate assistance to controls, is another important unit.

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LEAMINGTON SPA

CIVIL AVIATION NEWS . . .

and England throughout the year. An increase of over 60 per cent was seen on the Riviera services, and on routes to other parts of France the gains were as high as 205 per cent. On all the company's services linking Britain with the Continent the number of passengers carried was 59 per cent above the 1948 figure.

* * *

The Air Registration Board announces a further issue of seven Civil Aircraft Inspection Procedure Leaflets, making a total of 19 issued to date. The leaflets are obtainable from the A.R.B. Publications Department, Greville House, 37, Gratton Road, Cheltenham, Glos.

* * *

Claimed to be the heaviest single cargo ever loaded into an aircraft in Australia, a large road grader weighing 9,264lb was recently flown from Melbourne to Flinders Island in an A.N.A. Bristol Freighter. The unit was driven into the aircraft under its own power on special ramps, and the "air lift" enabled it to be put into operation at Flinders Island 24 hours after leaving a Melbourne factory.

* * *

Passenger arrivals and departures at Dublin Airport during 1949 reached the record total of 204,737. Of this figure Aer Lingus passengers accounted for 193,000; the remainder were carried by K.L.M. and by charter companies. Aircraft movements amounted to 16,926, and totals of 1,867,809 kg of freight and 138,450 kg of mail were handled at the airport.

* * *

On February 10th C.A.B. will begin an enquiry to determine whether a helicopter air mail and parcel-post service for the New York city area is required by what is picturesquely termed "the public convenience and necessity." The proposed service is similar to those already in operation in Chicago and Los Angeles. In addition to New York city, communities in Long Island, Westchester, New Jersey and Connecticut, all within a 50-mile radius of the city, would be affected.

FROM the CLUBS

TO open the 1950 flying season and to promote a still greater integration of the flying-club 'movement, the A.B.A.C. is organizing a so-called "Easter Aerocade." Held during the holiday period, Friday, April 7th, to Monday, April 10th, this will comprise a mass flight by club members in their aircraft, calling at the majority of clubs in Great Britain. It is expected that more than 70 aircraft will take part in the event, which will include a series of social functions arranged by individual clubs.

The intention is that the daily air-mileage should be in the neighbourhood of 200 to 220 and that between 20 and 25 clubs will be visited during the course of the week-end. The keynote is to be the elasticity of the programme and the freedom of the participants to deviate from it as they wish.

Members of the public will be invited to visit their local clubs during the visit of the "aerocade" and to inspect the aircraft and see for themselves how the flying club movement is developing. Details of the itinerary will be made available later.

The Association also announces that a summer convention is being organized for August 19th and that four club "At Homes" (Northamptonshire Aero Club, Blackpool Aero Club, Wiltshire Flying Club and Liverpool Flying Club) are scheduled for May 20th, June 10th, July 8th and August 5th respectively.

* * *

IN spite of extremely bad weather during the latter part of December, the Wiltshire Flying Club accumulated a total of 100 hours for the month, bringing the figure for 1949 to 2,147 hr. The last of the club's Magisters has now been sold, and the present fleet consists of five Autocrats and one Tiger Moth, in addition to the Dragon for any parties which may be organized. A new Auster, G-AHCR, has been purchased from Capt. Spencer Smith and is now undergoing C. of A. overhaul in the workshop. From February 1st it will be available to members at the reduced rate of £2 10s per hour solo; a limit of 120 hours applies to this rate.

Five officers from the Arab Legion have now almost completed training for their Private Pilots' Licences, two having already qualified and returned to their home country, and two pupils from Pakistan are now taking the pilots' course. The club now has three Austers, one Proctor, a Messenger and a Stinson for sale.

* * *

THE Boston Aero Club, inaugurated on October 22nd with 42 members, has now increased its paid-up membership to 76. It is hoped that the club-house will be completed and its interior decoration finished by the end of the month, and the securing of bar and catering licences is expected shortly afterwards.

The Auster aircraft belonging to Aerial Spraying Contractors, Ltd., will shortly be divested of its spraying equipment and will then be available as an additional two-seat aircraft for solo flying. The club is anxious to double its membership as quickly as possible, and any information with regard to flying or the club's activities are obtainable from the Secretary, Mr. G. N. Snarey, A.F.C., A.R.A.E.S., Wilsford House, London Road, Sleaford.

* * *

DURING 1950 the Cheltenham Aero Club is attempting substantially to increase the scope of its activities. Steps are being taken to provide the finance necessary for extensive improvements in accommodation and training facilities, the ultimate object being to develop the instructional side of the club into a first-rate training establishment. The organization will then be able to undertake all types of training up to the standard of Commercial Pilots' Licences, Instrument Ratings and Instructors' Certificates. A training syllabus has been drawn up and will, it is hoped, enable the club to qualify for M.C.A. approval for the 30-hour Private Pilots' Licence course, while night-flying facilities will be available in the near future. For an initial period the night rate will be 10s per hour more than the day rate, and pupils will be asked to assist in signalling and other duties connected with nocturnal operations.

* * *

NEWS from the Royal Aero Club of Queensland, Australia, indicates that 1949 was a record flying year with a total of approximately 6,000 hours, an increase of 2,300 over the figure for 1948. During the year 39 members qualified for "A" Licences and six graduated for Commercial Licences. Four new country centres were added to the training cadre.

* * *

AVIATION circles in South Africa believe that the Government will provide a subsidy which will amount to a little more than half the requested sum of £50,000, to aid private flying clubs. The Aero Club of South Africa is trying to reduce private-flying costs by urging a reduction of landing fee tariffs.

TAXI-LIKE: The Lycoming-powered Fokker F.25 Promotor is remarkable for its spacious cabin and ease of ingress and exit, which allow passengers to be dropped or picked-up speedily, so facilitating short-distance charter trips and work of a comparable nature. An initial order was completed some time ago.

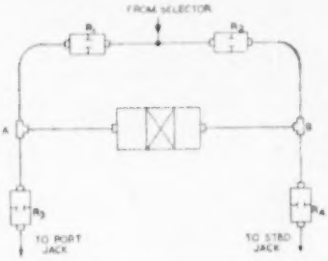
BALANCE OF POWER

New Hydraulic Device to Synchronize Duplicated Slave-elements

IN any mechanical system where separate drive-paths are taken from a common power source, the distribution of power will necessarily be affected by the resistance differential. In the case of a hydraulic system serving, for example, the flaps or undercarriage of an aircraft, the rate, and even sequence, of unit motion is to some considerable extent a matter of the degree of back-pressure involved in the separate branches. This is not of very great moment in the case of the undercarriage, but for flaps or air brakes asymmetrical movement cannot be tolerated, and it is for this reason that mechanical interconnection between the port and starboard surfaces has been, and is still, common practice.

To eliminate the necessity for mechanical interconnection, British Messier, Ltd., have developed a unit called a Flow Divider which, introduced into a hydraulic system, permits synchronized operation of two similar elements powered from a common source. The first application of the Flow Divider to a British aircraft is in the air brake circuit of the English Electric Canberra (*Flight*, December 15th, 1949).

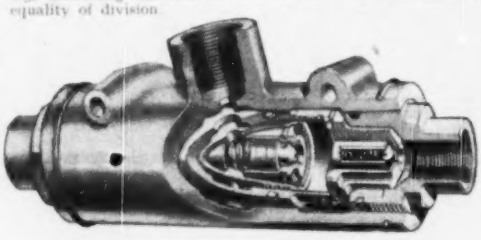
The Flow Divider is an unusual type of hydraulic valve, the function of which is automatically to divide the flow of fluid from one pipe into two equal flows, irrespective of variations in back-pressure which may exist in the two outlet pipes. By ensuring that the quantity of oil passing to each branch is held equal, the unit maintains coeval motion in each half of the service. The inaccuracy of division is below 5 per cent even with full load on one branch and zero load on the other.



Schematic diagram showing functional relation of the components of the British Messier Flow Divider.

The principle of operation is illustrated in the schematic diagram. Oil from the pressure source passes through two fixed restrictors (R_1 and R_2) and then to the two branches of the system through two variable restrictors (R_3 and R_4). At points A and B between the two restrictors in each branch is a connection to a cylinder, the volume of which is divided by a free-floating piston. Motion of the free piston is so arranged as to vary differentially the degree of restriction imposed by R_3 and R_4.

With a symmetrical flow through each branch, the pressure-drops through each pair of restrictions in each branch are equal, and thus the pressure on each side of the floating piston is equal. If, however, the back-pressure in, for example, the left-hand branch decreases, the fluid flow will tend to increase in this branch and decrease in the right-hand branch. Accordingly, the pressure-drop across R_1 becomes greater than that across R_2, and the pressure at A is less than that at B. The piston will therefore move to the left, and will so throttle R_3, restricting the flow in this branch and re-establishing equality of division.



Cut-away drawing to show disposition of components.

Construction of the Flow Divider is shown in the cut-away drawing. The two fixed orifices are, in fact, formed in the non-return valves contained inside the floating piston, and the variable restrictors take the form of small holes which are appropriately masked as the piston moves to the right or the left. In order to permit free return-flow in the system, internal non-return valves are used to by-pass each set of restrictions. A great deal of laboratory testing has been done on the Flow Divider and an inaccuracy of division of 5 per cent can be guaranteed, this being well within the performance generally required. With careful calibration of the orifices, however, it is possible to attain an inaccuracy of the order of 1 to 2 per cent.

In that the orifices are comparatively small, appropriate filtration of the oil entering the unit is necessary to avoid the risk of a choked orifice or seizure of the lapped-fit piston. That this new device is capable of valuable performance in achieving synchronization where mechanical interconnection is not possible has been established where the inherent characteristics of the unit have been understood and accepted.

AIR-LEAK DETECTION

WHATEVER the pros and cons may be in respect of pneumatic *vis-à-vis* hydraulic systems in aircraft, the fact remains that oil leaks are a good deal easier to detect if only because of the mess they make. At least, such has been the case up till now. However, with the introduction of what is known as the Type H leak detector, developed and made by the British Thomson-Houston Co., Ltd., the pin-pointing of even minute air leaks is made a matter of great simplicity.

The method employed depends on the introduction of a small quantity of suitable "tracer gas" into the air in the pneumatic system, so that any air escaping will carry with it a small percentage of the gas, to which leak detector itself is sensitive.

The instrument consists of a detector unit and a control unit, the detector being a hand-held probe, furnished with a plastic-tipped metal nozzle. The body of the unit contains an element sensitive to the vapours of halogen compounds (i.e., those containing chlorine, bromine, iodine and fluorine) and a motor-driven impeller which draws air through the element. A small loudspeaker built into the unit emits an audible clicking sound and, when the sensitive element detects the presence of vapour the frequency of the clicking increases, while visual indication of the leak is given by an increase in the meter reading on the control unit. The instrument will operate from a 190 to 260 volt a.c. supply; the consumption is 150 watts.

The tracer gas used is I.C.I. "Arcton 6", which has no deleterious effects on constructional materials and is non-toxic and odourless. Liquefiable at approximately 70 lb/sq in, it can conveniently be introduced into the system from small cylinders containing 1 to 2 oz of liquid.

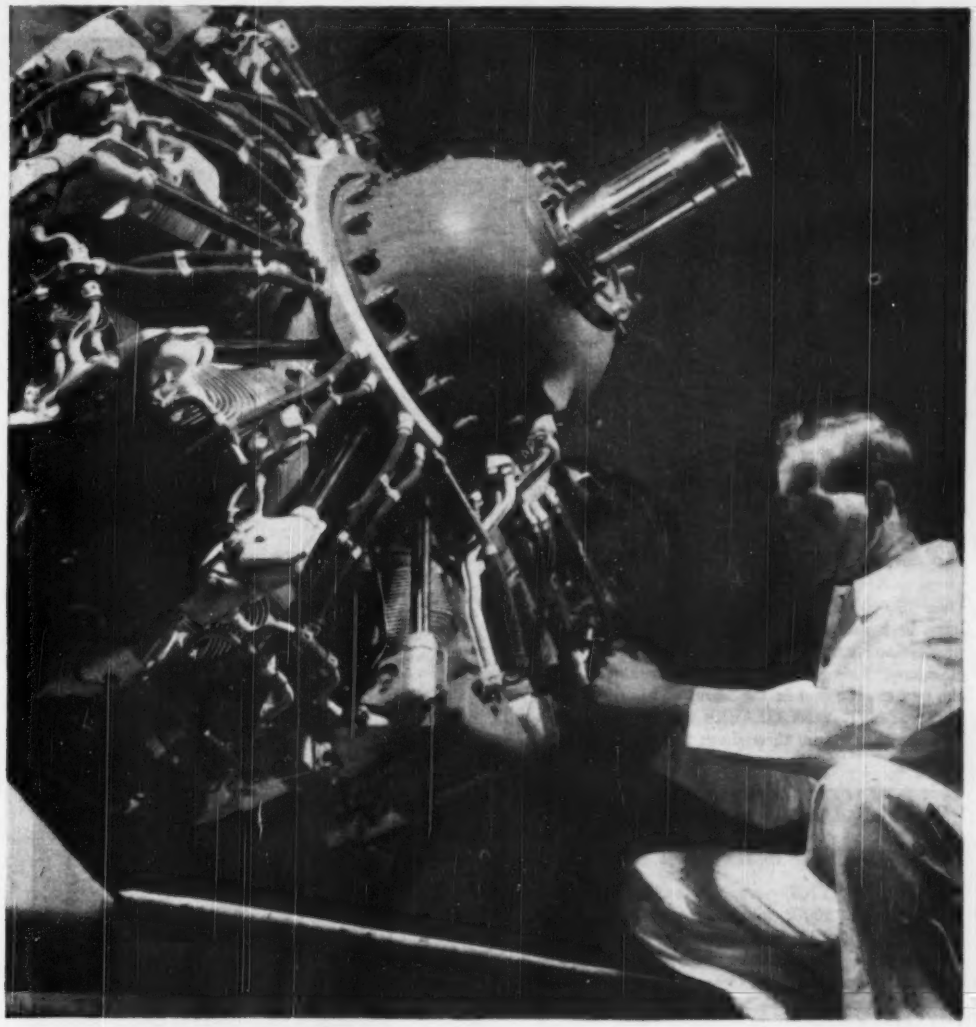
The sensitivity of the instrument is such that leaks passing air at the rate of 0.5 c.c./min with a tracer concentration of 1 per cent or less may readily be detected. In terms of a pneumatic system with a total capacity of 300 to 400 cu in and operating at 1,000 lb/sq in, this corresponds to a fall in pressure of 2 lb/sq in 24 hr/leak.

COMMERCIAL-FLYING TRAINING

A CHANGE of address—to 8-10, King Street, London, W.6 (Riverside 7400)—is announced by the London School of Air Navigation, the organization of which has been revised and the syllabus expanded. Started shortly after the war by a number of ex-R.A.F. officers, the school has since trained some hundreds of students wishing to put Service experience as pilots or navigators to good use in civil aviation.

Facilities available include full- or part-time tuition for licences (Commercial, Senior Commercial, Airline Transport, Instrument Rating, Flight Navigators'); short courses for R/T Licences; and Link Trainer instruction, including courses for Link instructors.

The school is, it is stated, recognized both by the Ministry of Civil Aviation and the Ministry of Education.



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Scientific

RECOGNITION in EXCELSIS

Close Finish to a Classic Contest

FOR large numbers of recognition enthusiasts the annual quest for the Aircraft Recognition Society's silver Hurricane trophy is now established as one of the major aeronautical events of the year. The meeting, which took place at the Science Museum, South Kensington, last Saturday, drew entries from 26 teams, and a considerable crowd of interested spectators packed the lecture theatre.

The competing teams, many of whom had travelled long distances to attend, provided a fair cross-section of the various groups that continue in these days of relative peace to make a major pre-occupation of the slightly recondite art of spotting. The A.T.C. entered nine teams, six were provided by the Royal Observer Corps, two by the R.A.F., and nine teams represented civilian groups. As in previous years, the civilians managed to show the Service teams a clean pair of heels, scoring first and second places with results that argued a truly remarkable standard of efficiency. On the first count two teams appeared to be running neck and neck for first place with 98 marks out of a possible 105. After some hard investigation work by G/C. Donaldson, who had courageously agreed to act as adjudicator, the North West London Branch of Air-Britain was found to be one point ahead of last year's winners, the Air-Britain Barking Branch. The decision turned on a wrongly quoted mark number—a photo finish in more senses than one.

Three teams tied for third place with 97 marks: the West London Aviation Group; No. 1 Air Navigation School, R.A.F.; and Post F.1 of No. 1 Group Royal Observer Corps. But perhaps the most remarkable achievement of the afternoon was that all three individual team members each scored 100 per cent marks: E. G. Ambrose (West London Aviation Group); B. F. Dutton (No. 4F Squadron A.T.C.); and C. F. Lancefield (Post 1.F.1, R.O.C.).

Afterwards Mr. Peter Masefield, who is president of the Aircraft Recognition Society, presented the trophy to the winning team and rounded off the meeting with one of those happily-phrased and thought-provoking little speeches of which he is a master. He said that he felt a remarkably high standard of skill had been shown, as he himself considered the test to be extremely difficult, and he reminded the audience that although aircraft recognition was at the moment a pleasant pastime for a Saturday afternoon, one could not feel certain that it might not at some time become once again a grim necessity.

BRISTOL ENGINE APPRENTICES REWARDED

THE annual distribution of prizes to apprentices of the Bristol Aeroplane Company's Engine Division took place recently, when over 100 prizes and certificates were presented.

In his report, the principal, Mr. H. Teasdale, said that many new educational facilities had become available to the apprentices during the past 12 months. With the assistance of the Ministry of Education and the Institution of Production Engineers, they had managed to persuade the Bristol College of Technology to provide a Higher National Certificate course in production engineering. Another big gap had been closed by providing a two-year evening course for the Licentiateship Examination of the Institute of Metallurgists.

Reviewing the achievements of the Apprentices' Technical School during 1949, Mr. Teasdale said that 93 per cent of Engine Division apprentices were successful in passing their examinations, as compared with 50 per cent in 1948. One brilliant performance was that of D. G. Dugdale, who was awarded a Whitworth Scholarship. Also worthy of special mention was the winning, by D. C. Mieen, of a Technical State Scholarship and an Ordinary National Certificate with three distinctions.

Mr. Teasdale also stated that it had been decided to accept boys with good Higher School Certificates for 12 months' practical training before entry to a university.

TALKING ABOUT HIGH MAINTENANCE COSTS

At a technical-committee meeting of the Inter-European Airline Operators, held at B.E.A. Headquarters, Northolt, last week, delegates from ten major companies discussed in detail methods of reducing the high maintenance costs caused by the price increases in American aircraft equipment and spares since devaluation. Left to right in the groups are (top left) Mr. P. Dencker, of D.D.L., Mr. R. C. Morgan, B.E.A. and Mr. L. Krantz, D.D.L.; (top right) Mr. H. W. Ree, D.N.L., and Captain P. McCormack, Aer Lingus; (bottom left) Mr. R. Blanchet, Air France, and Mr. F. G. Smal, Sabena; (bottom right) Mr. J. W. Horsman, K.L.M., Mr. P. C. F. Morgan, B.E.A., and Mr. J. D. Weirsma, K.L.M.

CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

That Hypothetical Head-wind

THE problems on head-winds posed by Mr. W. E. Thompson in your issue of January 12th are based on hypothetical situations which he quite rightly assumes to be impossible. It is not surprising, therefore, that the solutions to these problems, which are merely questions of relative velocity, are, in one case at least, seemingly fantastic.

Problem 1.—If an aircraft flying in still air at 200 kt encounters instantaneously a head-wind of 100 kt, its air speed will also instantaneously increase from 200 to 300 kt, but will then gradually fall off to 200 kt in exactly the same way as the air speed of an aircraft doing 300 kt would fall off if the throttle opening were suddenly decreased to that necessary to maintain 200 kt.

Problem 2.—If, in the same situation as in Problem 1, the air speed, by some means or other, is made to remain absolutely constant, then the ground speed will decrease instantaneously from 200 to 100 kt. To suggest that the occupants might experience a jerk forward in their seats is putting it mildly, since they would experience the same sensations (if they had the time) as would the occupants of an aircraft flying at 100 kt into a granite cliff-face.

J. V. STEDMAN.

Stansted Airport, Essex.

IT seems to me that Mr. W. E. Thompson's problems can best be regarded from a purely mechanical aspect. At the instant that the head-wind encounters the aircraft, the aircraft's momentum will be unchanged, and hence the true velocity that, relative to the ground, will be unaltered, the air speed rising instantaneously to 300 kt.

If the head-wind continues and the aircraft's attitude is maintained without change, the T.A.S. will return to 200 kt, the ground speed being then reduced to 100 kt.

The passengers will experience a deceleration, the rate of which will depend on the weight of the aircraft and upon its drag coefficient.

If, in the second problem, the assumption that the air speed remains unchanged is adhered to, the instantaneous deceleration would cause the passengers to depart hastily *via* the nose, with the tail in hot pursuit.

R. L. TOSSWILL.

Torquay, Devon.

Thunderstorm-flying

THE concise and lucid summary, by Capt. Brice, of the American report on thunderstorm research (*Flight*, January 12th) is both welcome and interesting—welcome because cumulo-nimbus has become a bogy out of all proportion to its actual unpleasantness and interesting because "cu-nim" has always before been rather a closed book in respect of its effects on aircraft and their occupants. Nevertheless, few will deny that passenger-carrying aircraft, if no others, should make a special point of avoiding "cu-nim," as no passenger, however hardened, relishes vertical gusts of the velocities described in the report.

The most useful line of development in countering thunderstorms would seem to be in perfecting an airborne radar apparatus to be carried by aircraft, which would indicate the more unpleasant areas of turbulence and precipitation, so that they could be avoided. Something on these lines was heard of a year or two ago, and more news would be welcome. The Americans have proved beyond reasonable doubt that the turbulence bogy is non-existent if properly handled, so that there need be little fear of thunderstorm-flying in most circumstances; but, all the same, few people want to be tossed about if it can be avoided by going round the worst areas—surely an H2S development could help achieve this?

However, the danger of hail is a very real one (at any rate in latitudes where the freezing-level is comparatively low), despite what the report says. During the last few months three aircraft have been damaged by hail in the Mediterranean area, two of them seriously; and in at least one of these cases the windscreen was penetrated by hail in several places, holes the size of golf balls being made. Having seen the windscreen myself, I can vouch for this. Among other items suffering considerable damage, the astrodome was destroyed. It is difficult to reconcile these hard facts with the reassuring statement in the report with regard to hail: in areas where hail is likely, pilots would still do well to keep clear of "cu-nim."

Finally, I feel Capt. Brice's rather superior, if indirect, imputation in regard to Service standards of instrument flying is unjust. During and immediately after the war, practically all aircraft flying were Service-operated; therefore, Service pilots naturally experienced a higher accident-rate than their civilian counterparts, whether or not the accidents had anything to do with cloud. As for the present time, standards of Service instrument-flying—at any rate so far as R.A.F. Transport Command is concerned—are at least as high as in any civil airline organization; and in Transport Command itself, almost certainly higher.

FIVE-BY-FIVE.

Herts.

[As Capt. J. C. Neilan implies on p. 94, everybody who can add to the still-slender store of recorded experience on this subject will be performing a useful service to aviation. To cloud-warning radar, mentioned by our correspondent, several references have appeared in *Flight*: in June, 1948, we illustrated the equipment designed by the Telecommunications Research Establishment; it has subsequently been developed by E. K. Cole, Ltd., and is now undergoing tests in B.O.A.C. aircraft.—ED.]

Farnborough Relic

I WONDER if any of your readers know the history of what looked to me like a Junkers Ju 90 which, all forlorn, lies on the top of a hill outside the perimeter track at Farnborough—and how on earth did it attain its weird and distinctly "dicey" location?

I have been a reader of your admirable journal for over 25 of my 42 years and can only say that I just don't know what would have happened without it!

DOUGLAS J. TAYLOR.

Worthing, Sussex.

It Depends What You Mean . . .

I DO not propose to comment on the letter published in *Flight* of January 12th, and signed "Azimuth," other than to point out that the editorial pencil did not correct a most obvious error of fact, which goes a long way towards invalidating the writer's arguments.

He says: ". . . it appears that the number of persons employed in the industry is not far short of the war-time peak." It all depends on what you mean by "not far short." The figures are approximately as follows:—

Wartime peak (January, 1944) ..... 1,821,000.
Present comparable figure .... Approx. 152,000.

E. C. BOWYER, Director.

London, W.1. Society of British Aircraft Constructors.

[As a matter of interest, we may recall that during the war it was estimated that the peacetime man-power would stabilize at approximately one-tenth of the wartime peak. In spite of the fact that some firms are standing-off men, at least temporarily until new orders are in hand, a slight upward tendency has recently been observed in employment figures.—ED.]

Wheels-up Landings

"PERTURBED Design Draughtsman" [Correspondence, January 5th] advocates reinforced fuselage-bottoms for crash landings, or "better still," a retracting skid or emergency landing wheel. Practical considerations of additional weight and complication make these two latter suggestions anything but "better still." The underside of the fuselages of many aircraft flying to-day are, as a matter of fact, stiffened locally to deal with belly landings; one light American twin-engined feederliner has two sturdy channel members riveted along the underside of the fuselage and has been landed on these without any damage to the aircraft.

I am sure that P. D. D. would be very unpopular with his stress colleagues if his suggestion of locking the undercarriage half-way down was adopted. The loads imposed on the conventional fore-or-aft retracting undercarriage system would be colossal, and the suggestion is inapplicable to sideways-retracting mechanisms.

I, too, have wondered why aircraft are still reported as having "cruised round for X hours to use up their fuel" when not so long ago many had fuel jettison pipes projecting visibly aft of their wings.

MAURICE F. ALLWARD.

London, S.E.19.

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SERVICE AVIATION

Royal Air Force and Naval Aviation News and Announcements

King and Queen at C.F.E.

THE King and Queen, accompanied by Princess Elizabeth and Princess Margaret, visited the Central Fighter Establishment at West Raynham, Norfolk, last Monday. Having motored over from Sandringham, their Majesties spent the afternoon inspecting aircraft and weapons.

8,000-mile Training Flight

SIX aircraft of the R.A.F. Central Navigation School left Shawbury on January 24th for an 8,440-mile training flight to Khartoum, returning on January 31st. Navigated by students of the specialist navigation course, they were to fly by way of Gibraltar and Cyprus, and return via Malta. The longest stage of the flight, the 2,250 miles from Gibraltar to Nicosia, Cyprus, would take 11 hours and be flown at night to allow celestial navigation.

National Service Engagements

ADDRESSING Officer Cadets under training at the R.A.F. O.C.T.U., Spitalgate, the Secretary of State for Air referred to the importance of leadership in the R.A.F. He announced that a scheme was now being introduced under which it would be possible for National Service men to extend their service to a total of three years in all or, alternatively, to take on a special three-year regular engagement at the time of entry. This, in effect, reduces the minimum regular engagement in the R.A.F. (now five years) to three years. It is hoped that this new scheme will appeal to National Service men who like Service life and are anxious to have more experience of it, but are not willing to sign on for a regular engagement of five years or longer.

The two new engagements, which are open to National Service airmen are:

(a) A total period of three years full-time service, including whatever period of national service has been completed before re-enlisting for regular service. This period will be followed by two-and-a-half years' service in the Class E Reserve. This engagement is intended for airmen who simply wish to stay on in the Air Force for an additional 18 months.

(b) A three-year Regular engagement which is open to men from the time they actually register for National Service, to be followed by Class E Reserve service to make a total of five-and-a-half years.

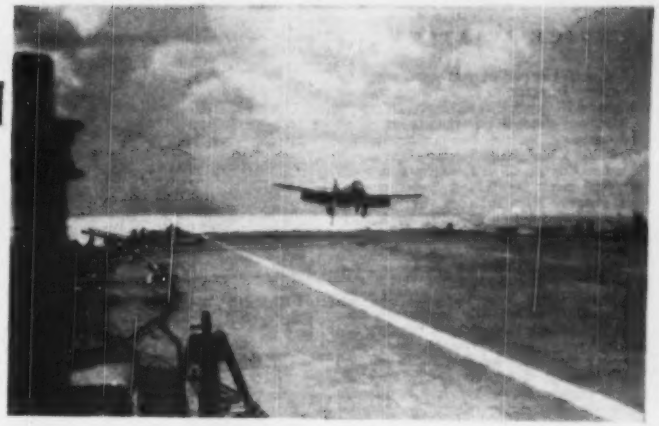
Service in the Class E Reserve is paid at a rate of from 1s to 1s 6d a day, according to rank, whereas service in the Class H Reserve, to which N.S.A. men are normally transferred, is unpaid. Men accepting the new engagements will not be involved in total full-time and Regular service longer than the five-and-a-half-years prescribed by the National Service Acts.

Benefits that National Service airmen will secure by re-engaging, or enlisting on call-up, under the new system, will be those at present extended only to Regulars. One benefit is choice of trade. At present many trades must be automatically closed to the National Service entry, owing to the length of training required, but those availing themselves of the offer will have the same right as the Regulars to choose any trade, provided that they have not already been mustered in a trade at the time of the new engagement, and subject to vacancies, for which they are suitable. Other benefits include the more generous scales of pay (increases of from 6d to 1s 6d a day according to trade and rank), clothing allowance, leave, terminal leave, free travel warrants and civilian outfit on discharge, of the Regulars. There will also be better opportunities for overseas service.

R.A.F. Regiment Commissions

SHORT-SERVICE commissions in the R.A.F. Regiment are to be offered to a number of ex-regular Indian Army officers who are between the ages of 34 and 44 and have held the substantive rank of major. Appointments will be for a period of six years on the active list, followed by four years on the Reserve of Air Force Officers. Gratuity at the rate of £100 for each year of service will be payable on transfer to the Reserve after satisfactory completion of the full period on the active list.

Under this scheme appointments will be in the rank of squadron leader and, while the possibility of promotion is not debarred, normally the whole period of service will be rendered in that rank. Former rank and service will be taken into account in determining seniority. Officers who are exceptionally suitable and are desirous of accepting permanent service with the R.A.F. Regiment may be considered for permanent commissions after their acceptance under this scheme, but in that event it would be necessary to take into account the compensation, retired pay or other benefit which they may have received from the Indian Government, and each case would have to be considered on its merits.



THE SEA HAWK ROOSTS: Taking full advantage of its generous flap area, the Hawker Sea Hawk naval fighter is seen coming in for a touch-down during deck trials. Formerly known by its specification number N.7/46, the Sea Hawk is powered by a Rolls-Royce Nene. It was described in *Flight* of November 10th last.

R.A.F.S.A.A. Honoured

HIS MAJESTY THE KING has been graciously pleased to become the patron of the R.A.F. Small Arms Association. Vice-patron of the Association is Air Chief Marshal Sir John Slessor and its president is Air Chief Marshal the Hon. Sir Ralph A. Cochrane. The Association, formed in 1921, has grown to a membership of nearly 7,500 from all ranks of the R.A.F. and W.R.A.F.

Treasure Hunt

THE adjutant of No. 609 (West Riding Squadron, R.Aux.A.F., Yeadon, near Leeds, is trying to trace some of the Squadron's trophies. They include two hunting-horns, now believed to be at a Yorkshire hotel; some tankards; original Squadron diaries—in the tracing of which it is hoped that Mr. Zweigler, war-time intelligence officer, may be able to assist; and the Squadron goat—believed to be alive and kicking, but whereabouts unknown.

Reserves Club Ball

THE annual ball of the R.A.F. Reserves Club will be held at the Dorchester Hotel, London, W.1, on Friday, February 3rd, from 10.30 hr to 0700 hr. This year, the function will take the form of a reunion, and the club's committee has secured the patronage of H.R.H. the Duke of Gloucester. Members requiring tickets (priced at 35s and including a three-course supper, dancing and cabaret) are asked to apply to the Secretary, R.A.F. Reserves Club, c/o. R.N.V.R. Club, 38, Hill Street, London, W.1. Evening dress or dinner jackets, without decorations, will be worn. Profits from the function will go to the R.A.F. Benevolent Fund.

Senior Appointments

THE Air Ministry announces the appointment of A.V-M. L. F. Pendred, C.B., M.B.E., D.F.C., as Commandant of the School of Land/Air Warfare. For the past three years, A.V-M. Pendred has been Assistant Chief of the Air Staff (Intelligence); he was formerly in South-East Asia, where he commanded No. 221 Group from August,

SERVICE AVIATION . . .

1945, until the end of that year, when he became Director of Intelligence at Supreme H.Q., S.E.A.C.

His war-time appointments included the command of two bomber stations, a year as Chief Intelligence Officer of Bomber Command and, in 1944, a similar post with the Allied Expeditionary Air Force. Born in 1899, he was first commissioned — in the R.N.A.S. — in 1917.

A.V-M. Pendred's successor as A.C.A.S. (Intelligence) is A. Cdre. N. C. Ogilvie-Forbes, C.B.E., who takes the acting rank of Air Vice-Marshal. A.V-M. Ogilvie-Forbes recently returned from Moscow, where he had been Air Attaché since April, 1948. Formerly, from 1945, he was Head of the R.A.F. Delegation in Belgium and Air Attaché in Brussels. He is 40, and joined the R.A.F. in 1922 from Cambridge University.

A. Cdre. L. F. Sinclair, G.C., C.B., C.B.E., D.S.O., has been appointed Assistant Commandant of the R.A.F. Staff College, Bracknell. He recently returned from Germany, where, after having taken the 1946 course at the Imperial Defence College, he went early in 1947 as S.A.S.O. of No. 84 Group, B.A.F.O. After the disbandment of 84 Group in the following December he commanded the Tempest Wing at Gutersloh until late in 1948, when he was appointed to command No. 2 Group on its re-formation in B.A.F.O. after having been disbanded for 18 months.

During the war A. Cdre. Sinclair commanded the Tactical Light Bomber Force in North Africa and Italy and was afterwards S.A.S.O., Balkan Air Force. He is 41, and was commissioned from Cranwell in 1928.

Until recently S.A.S.O. of 41 (Maintenance) Group, A. Cdre. G. Scarrott has been appointed Director of Equipment (B) at the Air Ministry. The new Director, who served with the Warwickshire Yeomanry and the R.F.C. in the first world war, has been with the R.A.F.'s Equipment Branch since 1923. Two new Medical Branch appointments announced are those of A. Cdre. J. MacC. Kilpatrick, who becomes Deputy Director-General of R.A.F. Medical Services, and A. Cdre. F. E. Lipscombe, who succeeds him as Director of Hygiene and Research at the Air Ministry.

New air attachés to Ankara and Moscow are, respectively, G/C. R. J. Legg and G/C. T. C. Bird; both officers take the acting rank of Air Commodore. A. Cdre. Legg, who was Air Attaché in Athens from 1930 to 1941 and in Washington from 1945 to 1947, has until recently been a Deputy Director of Policy (Air Staff) at the Air Ministry. The new Moscow attaché, A. Cdre. Bird, was formerly in New York, as deputy to the Permanent R.A.F. Member of, and as Chief Staff Officer to, the Military Staff Committee of U.N.O. (R.A.F. element).

POLICE PARADE: At a ceremony in Kensington Gardens on January 16th, No. 137 Flight, No. 5 District, London, received the de Putron Trophy from Maj.-Gen. Tans, Governor of the Hague, here seen inspecting the Flight with Air Marshal Sir Leslie Hollinghurst. The Trophy is awarded annually to the R.A.F. Police unit gaining highest marks for efficiency, turnout and drill.

Reunions

A REUNION dinner for No. 110 (H) Squadron, R.A.F. (Bangalore-Singapore), will be held on Saturday, March 11th, at the Chez Auguste Restaurant, London. Tickets (12s 6d) from E. H. Algar, 147, Sutton Common Road, Sutton, Surrey.

* * *

The third annual reunion dinner and dance of R.A.F. St. Mawgan (Transport Command) will be held in London on Saturday, March 25th. Those wishing to attend the reunion should contact Mr. Wilson, 17, Rectory Gardens, Hornsey, London, N.8.

FORTHCOMING EVENTS

Jan.	28.	Helicopter Association: "Pest Control and the Helicopter," by Dr. W. E. Ripper, F.R.E.S.
Jan.	31.	R.Ae.S. Section Lecture: "Further Problems of Aircraft Stressing," by J. H. Argyris, A.F.R.Ae.S.
Feb.	1.	R.Ae.S. (Preston): "Defence against the Flying Bomb," by W.C. R. P. Beamont, D.S.O., D.F.C., A.F.Ae.S.
Feb.	1.	Royal United Service Institution: "Aircraft for Army Uses," by Lt.-Gen. R. N. Gale, C.B., D.S.O., O.B.E., M.C.
Feb.	3.	R.A.F. Reserves Club: Annual Ball, Dorchester Hotel, London.
Feb.	4.	British Interplanetary Society: Discussion—"Effects of Interplanetary Flight."
Feb.	8.	R. Ae. S. (Brough): "Rocket Propulsion and Inter-Planetary Flight," by A. V. Cleaver, A. R. Ae. S.
Feb.	9.	R.Ae.S.: "Producing a Prototype Aircraft," by C. T. Wilkins, A.F.R.Ae.S.
Feb.	13.	Institute of Transport: Brancker Memorial Lecture—A.V.-M. D. C. T. Bennett, C.B., C.B.E., D.S.O.
Feb.	14.	R.Ae.S. Section Lecture: "Prototype Testing," by D. R. H. Dickinson, A.F.R.Ae.S.
Feb.	17.	Institute of Navigation: "Air Traffic Control," a symposium of papers.
Feb.	21.	R.Ae.S. (Belfast): "Strength-testing of Aircraft," by Dr. P. B. Walker, M.A., Ph.D., F.R.Ae.S.
Feb.	21.	R.Ae.S. Section Lecture: "Air-Intake Design for High-speed Aircraft," by Dr. J. Seddon, B.Sc.
Feb.	22.	R.Ae.S. (Preston): "Radar and the Aircraft which Use it," by B. W. Hodlin, B.Sc.
Feb.	22.	R.Ae.S. (Reading): "Propeller Turbines," by A. C. Clinton, F.R.Ae.S.
Feb.	23.	R.Ae.S. Graduates: "Problems of Heat Transfer," by W. R. Shapey, B.Sc., Grad. R.Ae.S., and J. Rivers, Grad. R.Ae.S.
Feb.	25.	Helicopter Association: "French Helicopter Development," by Col. R. M. Garry.
March	1.	R.Ae.S. (Preston): Lecturettes by Branch Members
March	1.	R.Ae.S. (Weybridge): "Do Scientists Know Anything?" by C. G. Grey, F.M.R.Ae.S.
March	1.	R.Ae.S. Graduates: "Engineering Problems of Aircraft Design." (Joint meeting with I.E.E. and I.M.E. graduates.)
March	2.	R.Ae.S.: "Design for Maintenance," by R. G. Bishop, F.R.Ae.S.
March	4.	British Interplanetary Society: "Testing of Rocket Motors," by Dipl. Ing. H. F. Zumpe.
March	7.	R.Ae.S. Graduates: "Gas-turbine Installation," by J. C. Wallin, B.Sc., A.F.R.Ae.S.
March	8.	R.Ae.C.: Ball, Londonderry House.
March	14.	R.Ae.S. (Belfast): "Problems of High-speed Flight," by H. Davies, M.Sc., F.R.Ae.S.
March	16.	R.Ae.S.: "Air Survey," by G/C. F. C. V. Laws, C.B., C.B.E.
March	17.	Institute of Transport: Annual Dinner.
March	21.	R.Ae.S. Section Lecture: "Boundary Layer at High Speeds," by A. D. Young, M.A., F.R.Ae.S.
March	24.	College of Aeronautics Senior Common Room Society: Annual Dinner.
March	25.	Helicopter Association: "Performance Testing of Helicopters," by F. O'Hara, M.A.
March	28.	Institute of Transport (Metropolitan Graduates): "Post-war R.A.F. Developments and their Effects on Civil Aviation," by A. J. Allum.
March	28.	R.Ae.S. Graduates: "Undercarriage Design and Testing," by G. S. Cranwell, Grad. R.Ae.S.
March	30.	R.Ae.S.: "Testing Aero Engines and Power Plants," by A. C. Lovesey, O.B.E., B.Sc., F.R.Ae.S.
April	1.	British Interplanetary Society: "Space Travel—Fact and Fiction," by A. C. Clarke, B.Sc.
April	5.	R.Ae.S. (Brough): "Flying-boat Design Problems," by H. Knowler, A.M.I.C.E., F.R.Ae.S.
April 7-10.		Association of British Aero Clubs: Easter "Aerocade".
April	8.	British Interplanetary Society (Manchester): Film Show.

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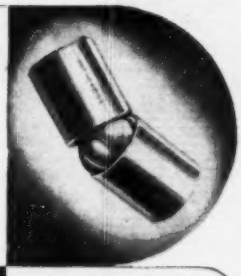

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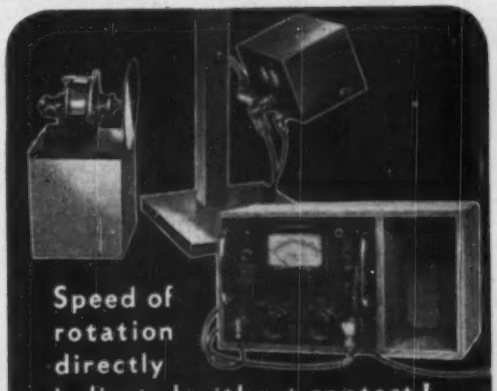

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